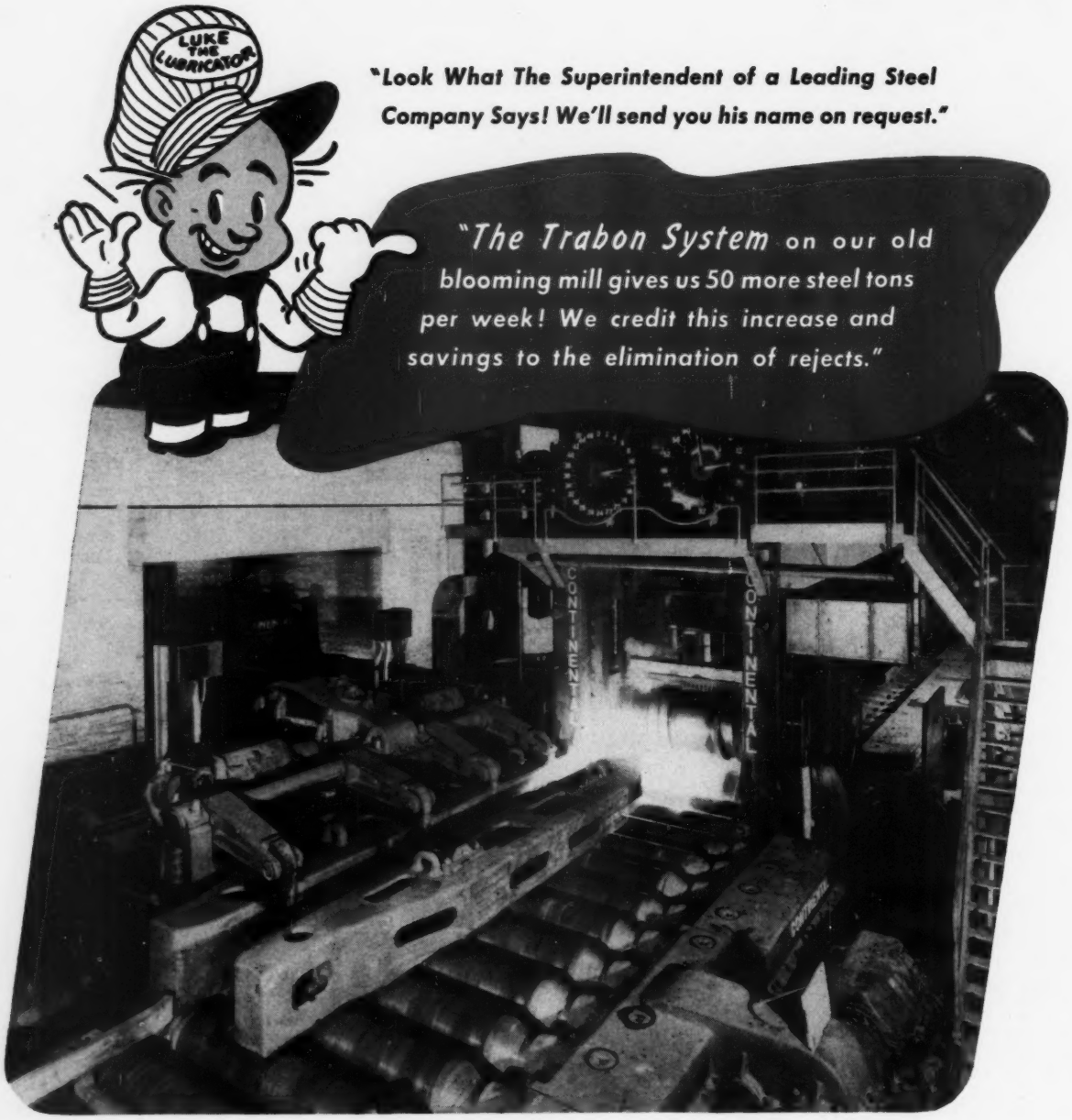
Lubrication ENGINEERING

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS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TIPS ON MACHINING Stainless Steel for Higher Production AT LOWER COST

DATA!

Page B-3

AUSTENITIC STAINLESS STEELS (Cont.)

Wide Variance In Machinability

Types such as 303 are considered free-machining 18-8 grades, while various other 18-8 grades such as types 321 and 347 are extremely difficult to machine. These latter types are especially serviceable at elevated temperatures and will be found to be used frequently for aircraft parts, particularly jet engine parts where extremely high heat may be encountered, and high strength is essential.

Cutting Fluids for Austenitic Stainless Steels

For the machining of all grades of stainless steel the presence of active or effective sulphur in the cutting fluid in varying amounts is vitally important as this quality tends to reduce the work-hardening characteristics and tendency of these materials to pick-up and weld to tool surfaces.

It should be pointed out that the severity of the machine operation has a direct bearing on cutting fluid application. Operations such as tapping, threading and broaching where slower speeds and heavier cuts are usually in evidence, require a cutting fluid high in active sulphur and factors of lubricity.

Generally speaking, however, the free-machining grades of austenitic stainless steel demand a balanced amount of active sulphur while types such as 347 require the maximum possible amount to prevent chip weld and provide smooth finishes.

PROOF!

STUART'S ThredKut 99 FOR STAINLESS

A Wisconsin manufacturer recently tried twelve different heavy duty cutting fluids for the tapping of type 310 stainless steel. One of the oils that failed sold for 45c per pound. Production with the best of these products amounted to 50 holes per tap. With Stuart's THREDKUT 99, production was increased to 550 holes per tap.

D.A. Stuart Oil Co.

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Lubrication ENGINEERING

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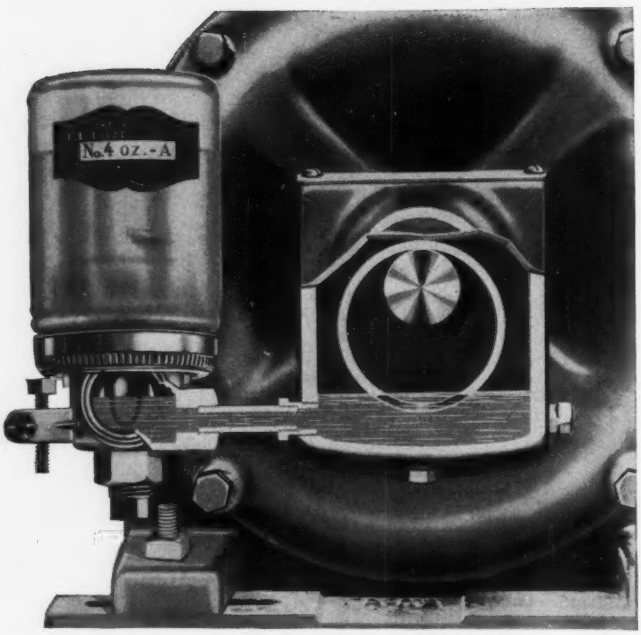

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3-3-50	390-4 oz. "
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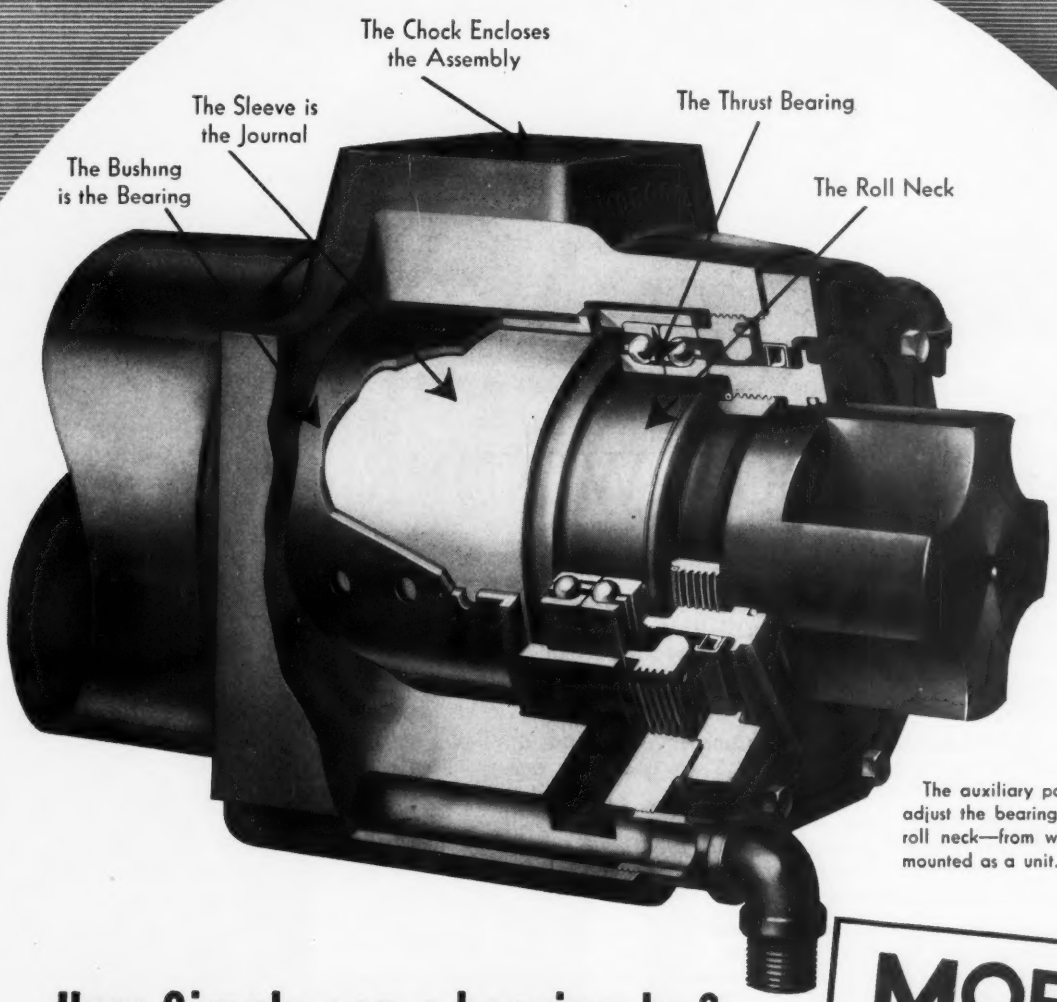

The auxiliary parts serve to seal and adjust the bearing and secure it to the roll neck—from which it is easily dismounted as a unit.

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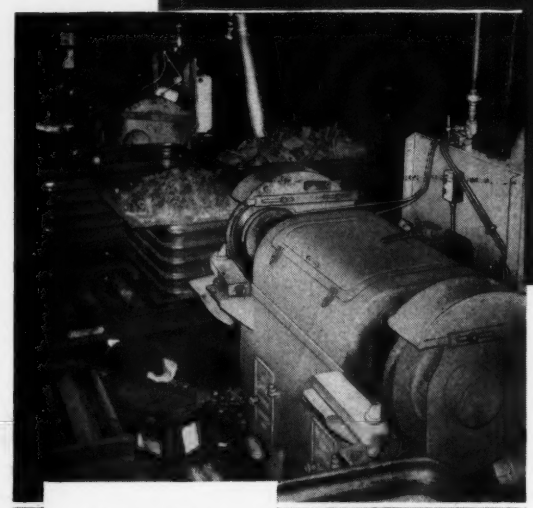
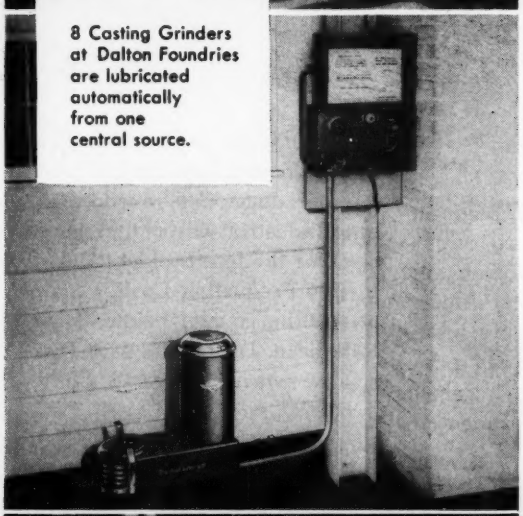
"More Than 60% of Bearing Trouble Eliminated Since Installing *Lincoln's* CENTRALIZED LUBRICATION..."



8 Casting Grinders at Dalton Foundries are lubricated automatically from one central source.



"Upon checking with our maintenance department, we find them quite enthusiastic over the results obtained from the Lincoln Centralized Lubrication System now installed on our grinders.

"While we have no exact figures for comparison, we believe that we have reduced our bearing trouble by at least 60% and have, undoubtedly, cut down lubricant usage. Of course, down-time for maintenance has been reduced in line with the 60% reduction in bearing trouble. We can, without reservation, recommend this method for use in other foundries."

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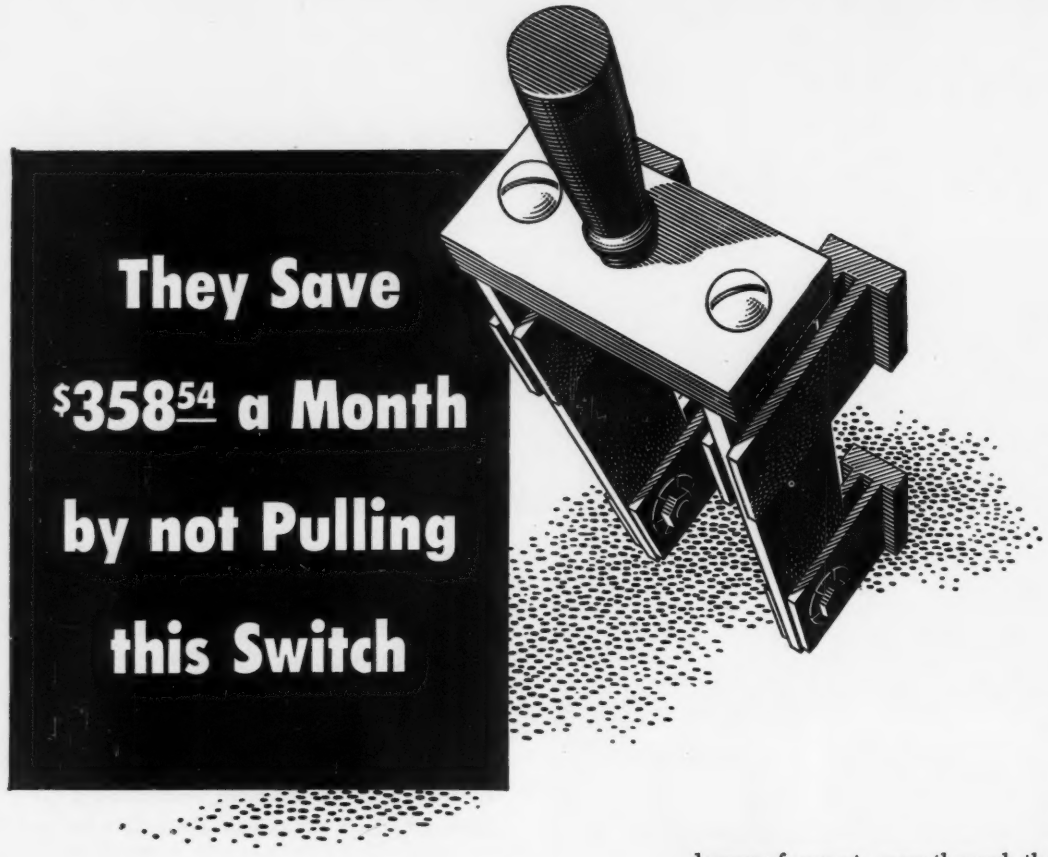

Every day the machinery in a Clinton, Mass. plant* had to be stopped for a half hour while those machines were lubricated. Every stop meant lost production time plus a $14 expenditure for lubrication.

The Clinton people called in an Alemite Lubrication Engineer. They wanted to know if they could eliminate the costly interruption in production time. They felt that lubrication was costing them too much.

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No matter what size or type of plant you operate, Alemite can show you dozens of ways to save through the more efficient handling of petroleum products. Call your local Alemite Industrial Distributor now or send for the free booklet "11 Ways to Cut Production Costs." Simply attach the coupon below to your letterhead. Dept. J-11, 1850 Diversey Parkway, Chicago 14, Ill.

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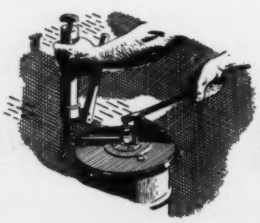
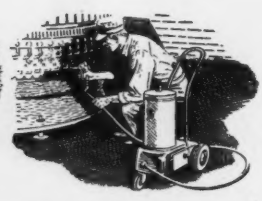


2. In loading grease guns... saves 3¾ man hours for every 100 pounds of lubricant loaded into hand guns.



3. In applying lubricants... saves up to 23.9 man hours for every 100 pounds of lubricant applied to bearings.

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We'll include facts on the new Alemite Oil-Mist System, too—[OIL-MIST atomizes oil into mist, circulates it to bearings under pressure. Increases life of bearings as much as 17½ times).

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Colloidal graphite is a solid lubricant, softer than talc. Its tiny tile-like particles slip on one another with amazingly little friction as a result of the particular arrangement of their atoms. The film formed by an application of colloidal graphite is microscopically thin, but far more durable than lubricating oil films. It is not subject to rupture except under conditions of heavy prolonged abrasion.

An interesting brochure on **"dag"** Colloidal Graphite for all Metalworking Operations is yours for the asking. Write today for Bulletin #426-12B

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Acheson Colloids Corporation, Port Huron, Michigan

. . . also Acheson Colloids Limited, London, England

Let's get the facts STRAIGHT

about oil fog...oil mist...oil spray lubrication

Widespread acceptance of the Norgren oil fog lubrication principle for air-powered equipment has brought many imitators, naturally.

Pride in our past achievements leads us to present the following facts, so that more of industry interested in better lubrication will get the facts *straight*.

Norgren pioneered in the development of the *oil fog principle* of lubrication *more than twenty years ago*. Being first in the field, Norgren naturally had to perform all of the fundamental research and basic experimentation which was necessary. The subsequent years of development have given Norgren an immense amount of enviable knowledge and experience about *oil fog lubrication*.

It often amazes us to see some air-oil lubricators come on the market and offer "new features" that Norgren developed years ago—most of which go back to the first Norgren lubricator on which patents have expired. Some of these "new features" are still used because they are basic just as the wheel is common to the buggy and the automobile. But—the Norgren lubricator has grown with the times through development of many new and finer improvements and still heads the procession in its contribution to refined lubrication in industry.

On high speed spindle lubrication, Norgren also took the lead. *Fourteen years ago*, we introduced the first Norgren oil fog lubricator into this highly specialized field—and many contributing developments followed. At that time, spindle speeds of 15,000 r.p.m. were considered high. But with this Norgren aerosol lubricator sensational results in longer bearing life were produced. Thus, the Norgren spindle lubricator was directly and solely responsible for the development of present high spindle speeds of 100,000 r.p.m. and more. This Norgren *oil fog principle* is the most widely accepted method of high speed spindle lubrication today.

No—*oil fog* lubrication is *not new* today. It is almost as old as the Norgren organization itself. And in the twenty years since it was born in our engineering "lab," Norgren has always led the field in important developments of the *oil fog principle*. Latest evidence of this leadership is our announcement of the *new and revolutionary Norgren Micro-Fog Lubricator*. Watch for it!

Norgren

C. A. NORGREN CO.
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Lube Lines

Summer Course at M.I.T.

To help meet the increasing need for formal instruction in lubrication engineering, the Massachusetts Institute of Technology announces a special two-week summer course to be held in Cambridge, Massachusetts, from June 11 to 22, 1951. This program, which has the sponsorship of the ASLE, is designed primarily for the engineer responsible for lubrication scheduling and maintenance in an industrial plant, who has had general engineering training but no specific instruction in the field of lubrication. It is also intended for engineering students who are interested in taking advantage of the growing demand by industry for men trained in this field.

The course will cover all the basic and special information needed by a lubrication engineer in meeting his responsibilities in an industrial plant, including the following subjects:

Theory of hydrodynamic lubrication
Bearing design
Fundamentals of dry and boundary friction
Bearing materials
Fluid lubricants of all kinds
Non-fluid lubricants, especially greases
Lubricating systems
Lubrication of ball, roller, and needle bearings
Lubrication schedules for plants
Selection of lubricants
Organization of a lubrication section

The program will also include panel discussions on selected topics, such as oil reclaiming, hydraulic systems, and the lubrication of special types of equipment. Throughout the course, emphasis will be placed on recent developments and their practical applications. Lectures and discussions will be supplemented by laboratory demonstrations.

The course will be under the direction of Professor John T. Burwell, Jr., of the Mechanical Engineering Department, who is in charge of the M.I.T. Lubrication Laboratory. He will be assisted by members of the Institute's staff, and several of the lectures will be given by representatives from industry who are noted authorities in their respective fields, and who are well known to the readers of LUBRICATION ENGINEERING.

Since enrollment in the summer course will be definitely limited, early registration is advisable. Letters of application should include the applicant's educational background and professional experience. The tuition for the two-week course will be $100.

M.I.T.'s new dormitory, the Everett Moore Baker House, will be available for those participating in the program. Rooms for single men, as well as a limited number of accommodations for married couples and single women, will be reserved if specifically requested in the application for admission to the course. The rate will be $3 per person per day, $18 per week, $28 per couple per week. Dining facilities on the campus will be open for all meals, and restaurants and hotels are located nearby. Summer guests are invited to use the Institute's libraries and recreational facilities which include tennis courts, the Alumni Swimming Pool, and the sailing pavilion on the Charles River.

Requests for further information and letters of application should be sent to Professor Walter H. Gale, Director of the Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

Metal Cutting

In metal cutting operations does the cutting fluid reach the tool edge to act as a lubricant?

In the search for the answer to this controversial question, a series of tests was conducted which pointed up some significant indications.

(Page 15)

ASLE Convention

For the first time in our publishing history we are able to present to our readers, a preview of our forthcoming National Convention. All subjects, authors, and pertinent details are announced.

This will enable our members and guests to make their plans well in advance and the prepublicity should augment the attendance to the point of making 1951 in Philadelphia the outstanding Convention and Show to date.

(Page 36)

Educational Series

"Lubricating Grease," by G. W. Miller, President of Battenfeld Grease and Oil Corporation of New York (page 10) is the second of our series of practical articles in the field of lubrication.

The subject of "Dispensing Equipment," which was originally scheduled for this issue, will appear at a later date.

April, 1951, will carry an article on "Gear Oil Additives," by Messrs. A. F. Brewer and P. J. Keating, Technical and Research Division, The Texas Company, New York City.

NUMBER 2

LUBRICATING GREASE

Mr. Miller became associated in 1915 with the old Cataract Refining Co. as laboratory assistant and was later placed in charge of the Chicago operations of this company.

In 1921, he returned to Buffalo to form the American Lubricants Co., of which he was President until his resignation in 1939.

He then assumed the Presidency of the Battenfeld Grease & Oil Corp. of N. Y., which position he holds today.

This makes for Mr. Miller an unbroken period of 35 years in direct connection with the development, production and application of lubricating greases.

by G. W. Miller
President Battenfeld Grease & Oil Corp. of New York
N. Tonawanda, N. Y.

Until close to 1800 the universal lubricant was beef or mutton tallow or a vegetable oil. It was not until after Drake drilled his first well that we find any record of lubricating grease, as we know it today, being manufactured. A commonly accepted definition of lubricating grease is a "combination of a soap or mixture of soaps and a petroleum product suitable for lubrication." A more recent suggested definition is "a solid to semi-solid product of the dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included."

In decades past lubrication presented no great problem. However, mechanical developments in more recent years have changed this picture, and today proper lubrication and application of lubricants is of extreme importance to industrial progress.

As a user or consumer of lubricating grease, one's interest lies in being able to recognize the grease by type or kind and what to expect from the product chosen. To do this, one must have some basic knowledge about the product.

Lubricating greases are produced in many types and forms, some very simple in formulation and some highly technical and complex. We will talk about the types in general use for average lubrication requirements, and place these lubricants in four general classifications.

1. Water-resistant type for applications from below zero to approximately 180 F. operating temperatures. This classification takes into consideration generally, calcium and aluminum base greases.

2. Water-soluble type for applications from average operating temperatures above freezing to temperatures ranging up to 300/400 F. and over—generally the soda base greases.

3. Multi-purpose greases — water-resistant types — covering both low and high temperature applications.

4. Greases using synthetic fluids in place of natural mineral oils.

In addition, we will discuss briefly additives, fillers and the value of the more common physical test procedures.

CLASSIFICATION No. 1
(Water-resistant type, generally calcium and aluminum base.)

Our first discussion will cover the normal calcium base grease. This type is produced by the saponification or cooking, with steam or open fire as a heating medium, a soap base composed of whole fat such as tallow, or fatty acids, with lime and water. After this base is completed, the chosen mineral or lubricating oil is slowly added along with the required amount of water to form the necessary emulsion of base and oil — the total amount of mineral oil added to the base determining the body or consistency of the finished grease. Using the N.L.G.I. numbering method, the No. 1 of course will be the softer grade, increasing in body as the numbers rise. A No. 1 grease normally will run approximately 90% lubricating oil, a trace to 2% water and about 10% soap, with worked penetration of 310/340 while a No. 5, which is a very stiff grade, may run 25/30% soap, water up to 2½ to 3%, and the balance lubricating oil, with worked penetration[1] 130/160. The viscosity of the oil, of course, may run anywhere from 30/35 seconds Saybolt at 100 to 5000 or over, and the V. I.[2] from below 0 to 100 plus. The use to which the grease is to be put will, of course, determine its body or consistency and the viscosity and V. I. of the lubricating oil used in it.

Assuming that only quality fats of the proper type and well-refined lubricating oils are used, the selection,

[1]The nomenclature "penetration" as used in this paper refers to the body or consistency of the grease as determined by the ASTM method.

[2]The initials "V.I." refer to the viscosity index or, in other words, quality factor of the oils determined by the Saybolt Universal Viscosity difference of various oils run at 100, 130 and 210 F.

then, of a calcium grease is governed by a few fundamentals; namely, the temperature at which the grease is to operate, the type of bearing, the speed of the bearing, the clearance, the pressure, and the frequency of lubrication.

For temperatures below freezing and below zero, a very light viscosity, high viscosity index lubricating oil should be used. Where temperatures are generally above freezing, a heavier viscosity oil is more desirable and high viscosity index of the oil of less importance. Likewise, the size and speed of the bearing and pressure involved also determine the viscosity of the oil and the consistency of the grease. It is safe to say that for normal requirements, the viscosity of the oil in the lubricating grease one decides to use should be about the same as if straight oils were used. One must keep in mind that lubricating grease is in reality a jelled oil and it is actually the oil that is doing most of the lubricating, although aided by the soap, and is kept in place by the soap from which the grease is produced.

Generally speaking, in selecting calcium greases, we should keep in mind that for very low temperatures a very light viscosity, high viscosity index oil should be used; for average temperatures a medium viscosity oil—perhaps in the SAE 20/30 range; and for higher temperatures and pressures reaching the maximum safety for calcium greases, oils in the SAE 50/70 range or even higher with medium range viscosity index.

Selection of consistency and oil viscosity depends, also, on the speed of the bearing and the design of the bearing, whether sealed or open and whether sleeve-type or anti-friction. For open-type sleeve bearings, heavier oil viscosity and consistencies in the #2 and #3 range are preferable. For sleeve-type bearings, well sealed, #1 and #2 consistencies are preferable. Where dirt, dust and water are encountered, the heavier body grease is preferred because of its better sealing ability. For anti-friction bearings, the medium viscosity oils are preferable and for normal speeds the #1 and #2 consistency range — for higher speeds and temperatures, #2 and #3 consistency, and higher viscosity oil, keeping in mind not to overfill the bearings at any time.

The most important factor to keep in mind when selecting a calcium base grease is that the normal calcium base greases generally are not safe to use for extended periods of time where operating temperatures will cause rapid evaporation or loss of the water content of the grease. The reason is very simple. Calcium base greases normally are a mechanical mixture or emulsion of soap, oil and water. Elevated temperatures tend to evaporate the water, which acts as a binder of the soap and oil, allowing the oil to separate readily and bleed away from the bearing leaving behind a heavy, sticky mass of soap which soon causes difficulty, especially in anti-friction bearings which normally are not lubricated as often as the sleeve-type bearing.

Where temperatures in an elevated range are consistent or extremes of temperature from low to high are encountered and it is desired to use calcium grease, possibly due to water resistance and ease of application, some of the difficulty due to separation can be overcome by frequent greasings, flushing out the old grease and replacing with new and fresh grease.

We might add, the type of fat used in the production of a lime base grease also determines its utility at elevated temperatures. As a rule, grease manufactured from fatty acids will give better service at elevated temperatures than grease produced from whole fats. There is less tendency for bleeding or oil separation when using the fatty acid type grease compared with the whole fat type grease.

The color of the grease has nothing to do with its ability to perform or not perform, providing refined oils are used, and is mainly psychological to the user. Normal greases are not dyed but obtain their color from the color of the lubricating oils and fats used in their production. In some rare instances, dyes are used to color greases as a brand identification.

Calcium base greases are good low temperature lubricants and when we speak of low temperature we mean temperatures from possibly freezing to well below zero.

In selecting a calcium grease for low temperature lubrication, viscosity, V. I. and pour point of the oil used in the grease are extremely important. Consistency and soap structure follow. The proper type of fat must be used for best results and the water content must be reduced to a trace. Such greases are available for low temperature lubrication, but are not recommended for use where the conditions, although involving a period of very low temperature operation may also involve periods of high temperature operation, too, because of possible physical change of the grease due to moisture loss, and extreme thinning and evaporation tendency of the light viscosity oils generally used in this type grease.

The second type of grease in this classification is aluminum base grease.

Aluminum base greases are very similar to calcium base greases in their general structure and physical characteristics. The manufacture differs somewhat from calcium base grease, although the general procedure is the same. Melting points are in about the same range, although aluminum greases can be used at slightly higher temperatures than calcium base greases due to the fact that they are water-free and will not separate due to loss of moisture.

Aluminum base greases may have an advantage over some types of calcium greases due to the fact that there is slightly less tendency for them to bleed oil and, therefore, for lubrication where some oil bleeding or capillary action would be detrimental—as in the lubrication of instruments, some canning equipment, certain textile machinery—aluminum base types may prove more satisfactory.

CLASSIFICATION No. 2

(Water-soluble type—generally soda base)

This classification covers the normal soda base or what is sometimes known as sponge or fibre grease. Like calcium grease, this type product is produced from whole fats or fatty acids, water and lubricating oil, but caustic soda (sodium hydroxide) is used in place of lime. The manufacture of soda base grease is very similar to that of calcium. Soda grease differs from calcium grease in that it is more nearly a chemical mixture of soap and oil and does not depend entirely on its water content to maintain its jell or grease structure; in fact, the lower the water content in a soda base grease the

better the grease. An excess of water generally causes the grease to become soft and lose its normal consistency under operating conditions or storage. We might add at this time that the nomenclature sponge or fibre is derived, not from the addition of fillers to the grease, but from its appearance due to the method of manufacture and raw materials used.

Soda base greases can be used as low temperature lubricants depending upon the viscosity and V. I. of the oil used and consistency and type fats used to formulate the base. When using them as low temperature greases, great care must be taken in their selection. Generally, below freezing and invariably below zero, even with light viscosity oils, soda base greases become very stiff and difficult to pump, creating high starting torques and in the case of small anti-friction bearings preventing bearing movement entirely.

Taking into consideration the frequency of lubrication periods, the safe high temperature limit of operation with a soda base grease is very close to its actual melting or dropping point. Again, the proper consistency depends upon the size of the bearing, clearance, speed, pressure, operating temperatures and frequency of lubrication. The general outline for selecting a calcium grease can be followed closely for soda greases with the exception that soda greases are not so desirable at temperatures below freezing, do give satisfactory lubrication at elevated temperatures well above 300 F., and should always be questioned when used in contact with water or steam.

Another fact to take into consideration in the selection of a soda base grease is its general structural appearance, whether a short, buttery type or a long, stringy, fibrous type. It is generally accepted that the short, buttery types of grease are most desirable for anti-friction bearings and general sleeve-type bearing lubrication due to the fact that there is less resistance to shear in the short fibred structure and less break-down of the grease due to operation of the bearing. For bearings such as coupler type, universal joints, etc., where throw-off due to centrifugal force is a factor, the stringy, long-fibred types are most desirable as the fibres tend to wind around the moving parts and thus resist throw-off.

Soda base greases are, of course, normally water soluble. However, the solubility of soda base greases can be modified to give some degree of water resistance depending on the type of fat and the viscosity and type of mineral oil used. Certain additives can also be used to decrease solubility.

In using a soda base grease under elevated temperatures, care must be taken to choose grease that will not bleed oil or thicken excessively due to oil evaporation. Therefore, it is necessary to determine the optimum temperature and speed at which a bearing will operate over a long period of time and then choose the grease accordingly. Keep in mind the fact that the lighter viscosity and high V. I. oils will have a greater tendency to bleed under operating and storage conditions than the medium or heavy viscosity oils of lower V. I.

Milled or Preworked Grease

Another important factor that must be given consideration in the selection of a grease lubricant, especially soda base greases, is the difference between its unworked and worked penetration. This is a greater factor in soda base than in calcium or aluminum base greases.

The softer grades — #0 to #2 consistencies — in calcium or aluminum greases are not affected to a great extent by the action of a properly lubricated bearing. However, the heavier consistencies—#3, #4, #5 and over—do show a large range between worked and unworked consistency and must be taken into consideration.

Soda base greases differ, however, in that practically all consistencies will show a marked breakdown in consistency or body on working.

To overcome this undesirable characteristic, greases of all types and especially soda base greases can be produced with higher than normal soap contents and then, when cool, milled or cold worked to the desired consistency for efficient bearing operation.

This preworking adds hours of life to the lubricant —less frequent greasings required—better sealing of the bearing obtained—less tendency to bleed—and a lower shear and torque. The milling operation predigests the grease to fit the bearing's appetite.

However, there may be certain applications where an unmilled grease should be considered if it can be applied properly. It may be desirable to have the grease which is retained within the bearing break to a soft plastic, forcing the stiffer unworked grease out to form a stiff shock-resistant seal.

CLASSIFICATION No. 3
(Multi-Purpose Greases)

The next classification covers the newer type multi-purpose greases which are being marketed today under various trade names and produced from barium or lithium soaps.

The barium base grease in general use is of a short, fibrous nature in appearance, highly water resistant, with melting point ranging above 400 F. The fact that this grease has very little breakdown under working—the work and unworked penetration reading about the same—puts it in the class of a multi-purpose grease, as only one consistency is generally required, although various consistencies in this type grease are available for special purposes. Barium greases have good operating characteristics over a wide range of temperatures from well below freezing to 400 F. or over. Barium base grease is an outstanding high temperature grease, and will operate at temperatures higher than the indicated ASTM dropping point, providing greasing periods are frequent enough to overcome or remove from the bearing undesirable by-products formed from the components of the grease due to exposure to temperatures beyond their physical limitations. This characteristic of barium grease is due to the fact that the product does not have a sharp dropping or melting point but is merely thinned down to a homogenous fluid lubricant at elevated temperatures, remaining plastic enough to prevent dripping.

Lithium base grease is similar in utility to barium grease but differs in appearance and in some of its general characteristics. It is smooth and buttery like the calcium greases. Its melting point ranges about 350 F. and its low temperature characteristics are somewhat

superior to barium. The water resistance of lithium grease is not as good as barium grease and falls somewhere between calcium and a good grade of soda base grease. Its retention in the bearing also falls below that of the barium type. However, like barium, one consistency—due to its ability to withstand breakdown under operating conditions, its resistance to water and general high temperature characteristics — fulfills the requisites necessary to classify lithium grease as a multi-purpose lubricant.

CLASSIFICATION No. 4
(Synthetic Greases)

Perhaps the newest development in lubricating grease is the so-called synthetic greases.

These products are produced in most cases by the use of normal types of soaps but substituting the synthetic types of hydrocarbons for normal mineral oils.

The greases have great possibilities in both low and high temperature operations and are produced in both water soluble and insoluble types in many consistency ranges and viscosity ranges of the fluids.

If a lubrication problem is one of wide temperature variation, rapid oxidation, gumming, etc., the synthetic product will be of great interest. Many of them, unlike normal greases, have little or no effect on natural or synthetic rubber.

Due to the extremely high viscosity index and low evaporation point of some of the synthetic fluids, ideal combination low and high temperature greases are produced.

The high temperature greases lubricate at elevated temperatures over extended periods of time without leaving a residual deposit usually found when using normal greases.

The Value of Physical Tests vs. Performance

The question of whether physical and chemical tests are an aid in the proper selection of a grease lubricant is often asked.

Conventional physical and chemical tests are excellent for controlling the uniformity in manufacture—and even for that purpose such controls have their limitations. Two greases with identical physical tests and of the same formulation will give different results when placed in a bearing under identical operating conditions. In addition to physical tests, there must be correlated performance tests that really give the right answers. A regular ASTM worked penetration taken at 60 strokes and 77 F. means very little as to performance. Some value, however, can be placed on this test provided a correlation is worked out between an unworked and worked penetration which may give some indication of the breakdown in structure during bearing operation. This would be only an indicative figure and could not be relied upon as a definite answer to performance. Accelerated tests to give such answers have been set up and are proving of value in the selection of the proper lubricant for a specific operation.

A grease may do a satisfactory job in a bearing operating at 150 F. but may be a failure at slightly lower or higher temperatures. Accelerated performance tests will give the proper answer and aid in the selection of the proper lubricant.

The ASTM melting or dropping point, viscosity index of the lubricating oil, acidity, alkalinity and the numerous other physical and chemical tests are all good indications and controls but in reality mean very little in the way of actual performance.

Additives for Lubricating Greases

For bearings operating at higher temperatures and heavier loads than normal, oxidation inhibitors and extreme pressure additives are available.

Oxidation inhibitors also act somewhat as a stabilizer and rust preventive by inhibiting the actions that may be the cause of bearing corrosion.

For heavier than normal loads, there are many types of extreme pressure additives available and some thought must be given to their proper selection.

With a known load, speed and bearing size it is not difficult to determine if an E. P. grease is required. Keep in mind that grease in itself has much greater load carrying capacity than the oil it contains or the straight oil one may be using. This is due partially to the soap or base used to form the grease structure.

In selecting the proper extreme pressure additive, take into consideration bearing structure, composition and atmospheric conditions. All of these will react on the chemical used. Wear factor is an important phase that can at times be traced back to the activity of the additive.

Fillers

Fillers are commonly used in many greases for special operating conditions. Such fillers as graphite, carbon black, mica, lead, zinc and other metallic compounds find their way into special formulations to impart what we might term "solid lubrication."

Fillers of the above-mentioned types are desirable where extremely heavy loads and intermittent starting and stopping are encountered—or shock loads such as in steel mill roll bearings, rubber mills, etc. Starting torque and bearing wear are greatly reduced in such operations by the use of the so-called solid type lubrication obtained through the use of fillers. The filler forms a solid film between the metal parts of the bearing and is not squeezed out during shutdown or shock.

Some of these fillers are mild lapping and polishing materials and therefore should only be used for slow speed applications. Under very severe loads where greases and oils will not lubricate the surface, these fillers permit a relatively low rate of wear. They may be used for some high speed applications if the bearings run the majority of the time with a grease film which is thicker than the particle size of the filler. Under this condition, the filler does not polish the shaft and bearing.

Application

Proper application is as important as choosing the proper lubricant.

The necessary frequency of lubrication periods is easily charted, if one gives due consideration to the many factors involved and already mentioned.

The method of application will determine somewhat the consistency. Grease cup and hand guns allow the use of heavier-bodied or unworked greases. Automatic greasing units call for softer consistencies for satisfactory operation.

Should the bearing call for a heavier body than the lubrication system will handle, a well-milled grease may be the answer.

Over-lubrication is as dangerous as under-lubrication. Do not force the bearing to do extra work, creating added heat and friction with possible lubrication and bearing failure.

Summary

To summarize, there is no mystery or difficulty connected with the selection of a lubricating grease to lubricate properly the majority of bearings in operation—where a grease-type lubricant can be used to greater satisfaction than a straight oil.

No product, whether it is steel, wood, paint or lubricating grease, will give service beyond the physical properties inherent in that product. If the requirement goes beyond that point—research, development and further engineering are involved and the application becomes a special problem.

It may be that other conditions beyond the bearing and equipment may have to be taken into consideration in such development—atmospheric conditions—product contamination—contamination of the lubricant by the product—accessibility of the bearing for frequent lubrication—heat other than that generated by the operation itself. All of these factors are involved where special application is indicated.

Many bearings now operating on oil lubrication can be more satisfactorily grease lubricated with a resulting increase in bearing life, cost reduction and safety factor.

In selecting the proper lubricant, do not guess. Have all the facts—type and size of bearing, speed, clearance at normal and at operating temperature, maximum operating pressure in P.S.I., maximum high or low temperature, frequency of lubrication periods, possible contamination by product or atmosphere.

With this information and using the proper mathematical formula, consumer or his supplier can quickly determine the type and grade of lubricating grease that will give satisfactory service.

The problem becomes greatly simplified and can be further simplified if sufficient thought is given to lubrication by the design engineer of both equipment and bearings.

TOOL ENGINEERS MEET

The annual meeting of the American Society of Tool Engineers will be held in New York City, March 15 to 17, inclusive, with headquarters at Hotel New Yorker.

The three-day program will include 28 panel sessions and 9 conducted plant tours.

Of special interest to readers of LUBRICATION ENGINEERING will be the several intensive discussions on Lubricants and Their Uses in Forming Metals:

E. L. H. Bastian, Chief Engineer of the Shell Oil Company, will speak on "Lubrication Practices in Forming of Metals."

"Raising the Limits of High Speed Steel" will be the subject handled by W. R. Frazer, Chief Metallurgist of the Union Twist Drill Company.

Mr. W. E. Coomey, General Superintendent of Rice Barton Corporation, will have the subject "Raising the Limits on Carbide."

Mr. W. A. Winblad, head of the Milling Estimating Division, Cincinnati Milling Machine Company, will speak on "Criteria for selecting Production Milling Methods."

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AN INVESTIGATION OF THE FLOW AND EFFECT OF A CUTTING OIL IN MACHINING OPERATIONS *

by W. E. Lauterbach and E. A. Ratzel †

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He is now a Research Engineer at Armour Research Foundation where, during the past five years, he has been the Project Leader on two long-range research programs in the Materials Engineering Section.

After receiving his B.S. degree from Illinois Institute of Technology in 1941, Mr. Ratzel joined the Armour Research Foundation as an Associate Engineer.

Since 1948 he has been on the staff of Midwest Research Institute as a Research Engineer.

ABSTRACT

This paper presents the results of an investigation into the flow and effect of a cutting oil in certain cutting operations conducted at surface speeds between 2½ fpm and 200 fpm. It is concluded that, for very low cutting speeds (below approximately 10 fpm for the particular cutting conditions employed in these experiments), the cutting oil penetrates between the tool and workpiece and between the tool and chip, entering from the clearance crevice (crevice formed by tool and workpiece) and not from the rake crevice (crevice formed by tool and chip). At higher cutting speeds, penetration of the cutting oil between the tool and workpiece and between the tool and chip from either the clearance crevice or the rake crevice could not be detected by the method used. The results of these experiments lead to a better understanding of the role of the cutting oil in the metal cutting process and, therefore, should be of interest to both producers and users of cutting oils.

Introduction

A study of the mechanism of cutting oil action during any given metal cutting operation raises the following important questions: Does a cutting oil actually penetrate between the tool and chip, and between the tool and workpiece? If so, how does it get there, and what is its effect on the cutting operation? The results of the experiments described in this paper indicate some interesting answers to these questions.

Two different experimental arrangements were employed for these tests. The first made possible low-speed planing cuts, 1 in. in width and 8 in. in length; the second made possible higher speed turning cuts which produced chips 1 in. in width.

In order to be consistent and thus avoid possible ambiguity, the thickness of the metal removed by the tool (thickness of the uncut chip) is denoted as the depth of cut in both the planing and the turning tests which are discussed in this paper. This definition agrees with the general machine shop parlance for a planing operation. However, it does not agree with the usual terminology employed for a turning operation; conventionally, the thickness of the metal removed is called the feed, and the radial distance from the uncut surface of the workpiece to the tip of the tool is termed the depth of cut.

During the test cuts on both the lathe and the mill, the amount and the point of application of the cutting oil, a sulphurized mineral oil, were controlled carefully by dispensing the oil from either a medicine dropper or a 5 cc hypodermic syringe, both of which were equipped with special nozzles. Examinations of the inch-wide chips and the finish surfaces produced during these cuts made it possible to study the action of the cutting oil on the cutting operation.

*The results presented were obtained during an investigation sponsored by the Shell Oil Company at Armour Research Foundation, Chicago, Illinois.

†Now on the staff of Midwest Research Institute, Kansas City, Mo.

Planing Test Cuts

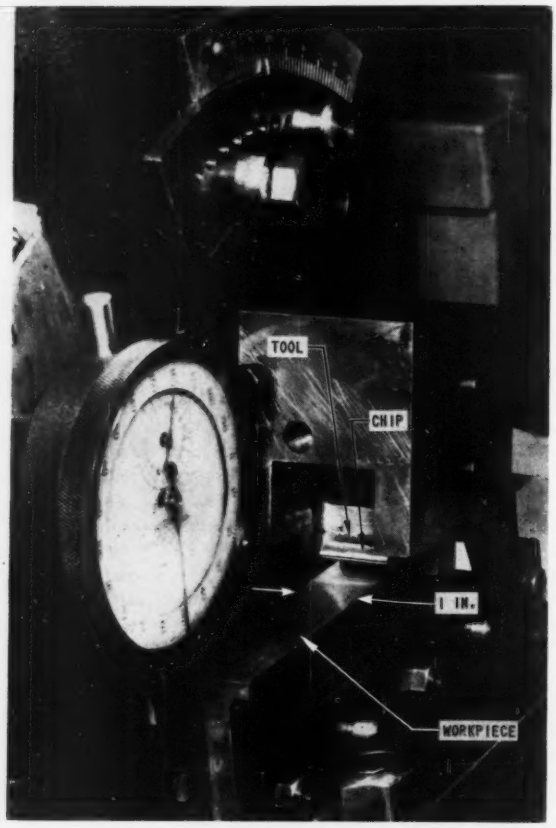
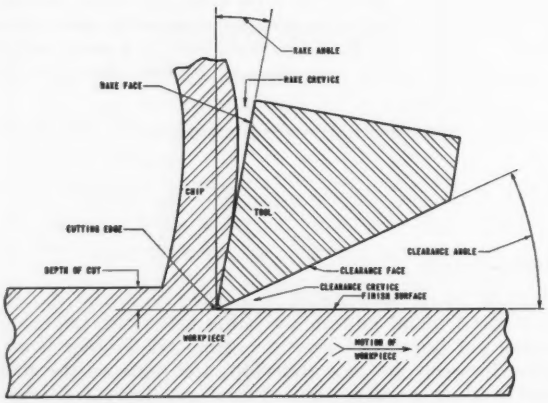


Fig. 1

For low-speed planing cuts a milling machine was adapted as a planer as illustrated in Fig. 1. The work material was a welded "T" made from two flat bars of SAE 1020 cold-rolled steel, bolted with angle irons to the bed of the mill. The cutting tools were high speed steel, 3/8 in. square by 3 in. long, ground on one long side so as to produce a 1 1/4 in. cutting edge with a 55 deg. included tool angle. These tools were clamped securely and rigidly in a variable-rake-angle tool holder attached to the arbor support of the machine. A large number of planing test cuts were made at a cutting speed of 2 1/2 fpm, at a nominal depth of cut of 0.005 in., and with a rake angle of 10 1/2 deg. (clearance angle of 24 1/2 deg.). Certain representative cuts which are the most significant in relation to the objective of these experiments are depicted in the following illustrations. It is emphasized that these illustrations show typical experimental results obtained from many test cuts. Additional test cuts were conducted under the same cutting conditions, with single exceptions of (1) a different cutting oil, (2) a rake angle of 20 1/2 deg. (clearance angle of 14 1/2 deg.), (3) a rake angle of 10 1/2 deg. (clearance angle of 4 1/2 deg.) using a tool with an included angle of 75 deg., and (4) a cutting speed of 7 1/2 fpm. All of these experiments gave similar results.

Fig. 2

Fig. 2 presents a cross-sectional sketch of the tool, workpiece, and chip, in which the depth of cut and the chip thickness are exaggerated for the sake of clarity.



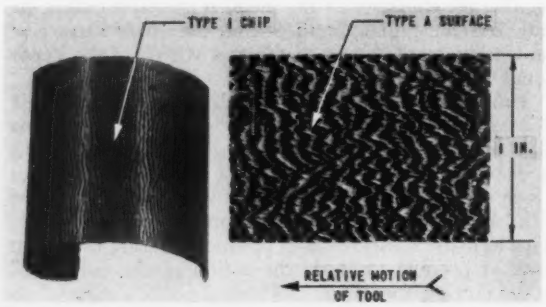
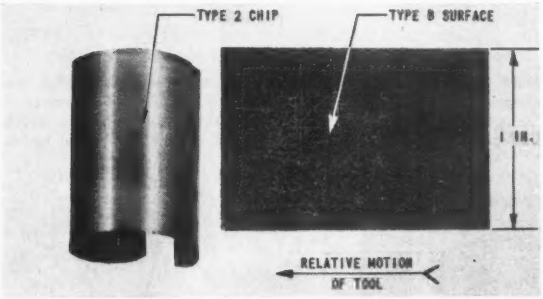


Fig. 3

A dry test cut (no cutting fluid) produced a uniquely patterned finish surface (designated as Type A) and a rather brittle discontinuous chip (designated as Type 1). A photograph of the chip and of a portion of the surface is given in Fig. 3. The workpiece passed under the fixed tool from left to right (Fig. 1 and 2); i.e., the cutting proceeded from right to left across the surface pictured in Fig. 3.

Fig. 4

A test cut in which both the rake and clearance crevices were completely flooded with the cutting oil produced a relatively smooth finish surface (designated at Type B) and a ductile, continuous chip (designated as Type 2) as shown in Fig. 4.



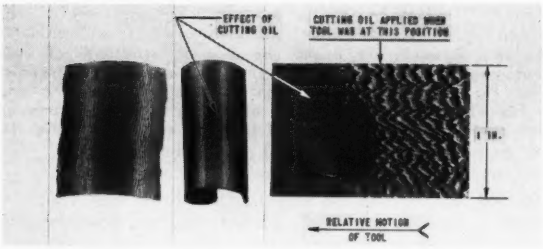
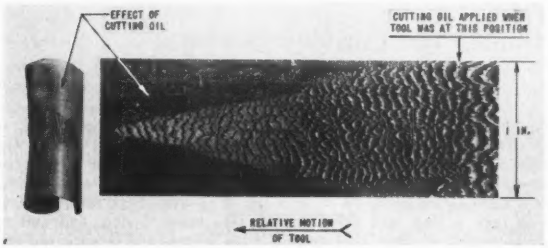


Fig. 5

A test cut was conducted dry for approximately half the length of the workpiece. Then, without stopping the cut, a large quantity of cutting oil was injected into the center of the clearance crevice midway between the edges of the workpiece. The resulting chip and surface are presented in Fig. 5. The Type A surface and Type 1 chip occurred for dry cutting, and the Type B surface and Type 2 chip were produced by the cutting oil. The curvature of the surface transition (concave into the Type A surface) shows that the cutting oil had its first effect on the cutting operation at the center of the workpiece where it first came into contact with the tool and workpiece.

Fig. 6

Fig. 6 is a photograph of the chip and surface produced when a large quantity of cutting oil was injected into the center of the rake crevice midway between the edges of the workpiece shortly after the test cut began. The surface changed from Type A to Type B and the chip from Type 1 to Type 2 after the oil had reached the edges of the workpiece and had flowed around the sides of the workpiece into the clearance crevice. These changes in the chip and surface corresponded directly to the flow of the oil into the clearance crevice from each side as evidenced by visual observation during the actual test cut. Note the sharp "V" line of transition on both the chip and surface. This means that the cutting oil in the rake crevice did not influence the chip and surface formations, whereas the cutting oil in the clearance crevice produced characteristic changes in the chip and surface. The cutting oil used during these tests showed fluorescence under ultraviolet light. When the surface, shown in Fig. 6, was viewed under ultraviolet light, the Type B surface fluoresced because of the oil which had flowed into the clearance crevice from each side of the workpiece. However, the Type A surface showed no fluorescence whatsoever. This strongly indicates that the cutting oil which was applied in the rake



crevice did not penetrate directly down between the chip and tool, and between the workpiece and tool.

The Type A surface and Type 1 chip characteristic of dry cutting showed absolutely no change during a test cut in which cutting oil was applied sparingly in the rake crevice. The workpiece did not fluoresce under ultraviolet light. Again, this indicates that the cutting oil did not penetrate from the rake crevice down between the tool and the metal which was being cut.

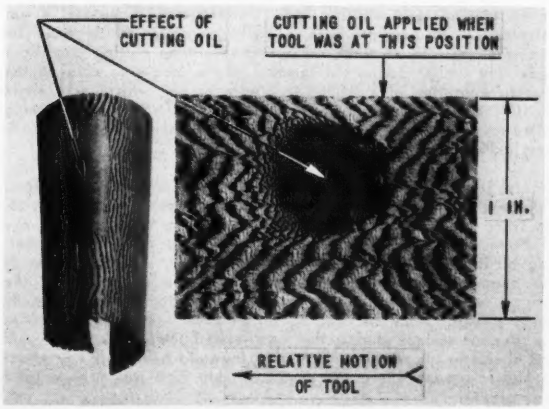
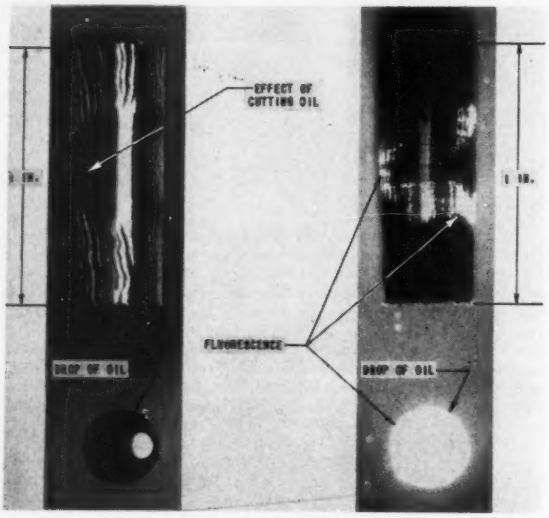


Fig. 7

Fig. 7 illustrates the change in the chip and surface caused by the injection of one drop of cutting oil into the clearance crevice during a dry test cut. The spot of Type B surface on the workpiece, and the small portion of Type 2 chip, correspond to the point of application of the oil. The Type 2 portion of the chip was continuous throughout its thickness, and was surrounded completely by a discontinuous chip formation. This chip was examined under ultraviolet light, and it was observed that the Type 2 portion gave faint fluorescent indications in streaks which were parallel to the length of the chip. The remainder of the chip showed absolutely no fluorescence. This means that cutting oil was present on the Type 2 portion of the chip and not present on any other part of the chip. This provides conclusive evidence that at this low cutting speed the cutting oil penetrated between the workpiece and tool, and between the chip and tool from the clearance crevice, and thus influenced the chip and finish surface.

Fig. 8

Nine ounces of anthracene, a highly fluorescent material, were dissolved in one pint of cutting oil at 200 F. A few drops of this "sensitized" oil were injected into the center of the clearance crevice during a dry test cut. Fig. 8 shows the resulting chip and surface.



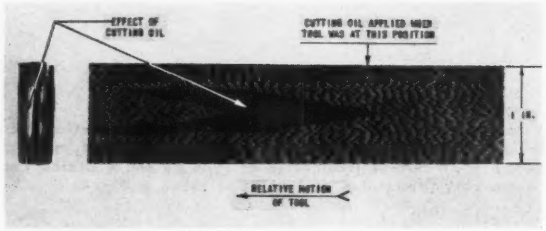


Fig. 9
(Fig. 9a on left, Fig. 9b on right)

The chip shown in Fig. 8 and one drop of "sensitized" oil were photographed under white light, Fig. 9a, and under ultraviolet light, Fig. 9b. It can be seen that the fluorescence on the chip in Fig. 9b, showing the presence of cutting oil, appears only on that portion of the chip which is recorded as Type 2 in Fig. 9a.

Turning Test Cuts

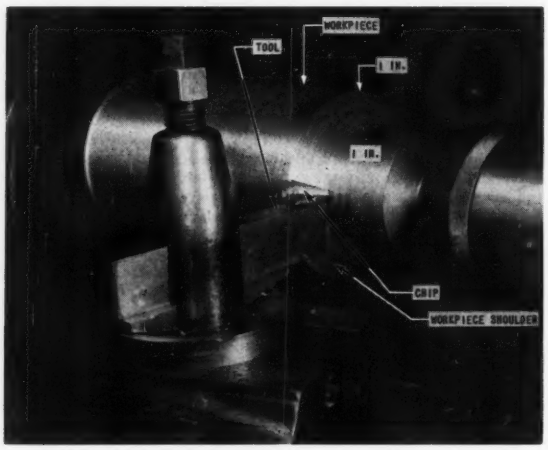
Fig. 10

For higher speed turning cuts a heavy duty lathe was used as illustrated in Fig. 10. The work material was an SAE 3140 steel log with an original diameter of 8 in. The cutting tools were high-speed steel, ¾ in. wide by 1⅜ in. deep, ground to an approximate tool designation of 3, 10, 6, 6, 6, 15, 0 (3 deg. back rake, 10 deg. side rake, 6 deg. end relief, 6 deg. side relief, 6 deg. end cutting edge angle, 15 deg. side cutting edge angle, and 0 nose radius). The side cutting edge was approximately 1⅛ in. long. A deep groove was ground into the center of the side clearance face, extending from the bottom of the tool to within 1/32 in. of the cutting edge. This groove served as a guide for the introduction of cutting oil into the center of the clearance crevice. These tools were clamped in a standard tool holder on the lathe compound.

Turning test cuts which produced chips 1 in. in width were made at cutting speeds between 10 and 140 fpm and at depths of cut between 0.003 and 0.040 in. per rev. As previously stated, the side rake angle of the tool was approximately 10 deg. and the side relief (clearance) angle was approximately 6 deg. Under these cutting conditions, only continuous chips (Type 2) and smooth finish surfaces (Type B) were produced.

In these experiments, a dry test cut was begun and, as soon as the chip took the form of a smooth ribbon, the special nozzle of the hypodermic syringe was lodged into the groove in the clearance face of the tool, and "sensitized" cutting oil was injected at a velocity of approximately 1500 fpm directly into the center of the clearance crevice. The cut was stopped immediately after the application of the oil. The chip was removed from the shoulder on the test log and viewed under ultraviolet light.
In accordance with this procedure, a large number of test cuts were conducted at various combinations of the depths of cut and cutting speeds mentioned. No fluorescence was observed on the chips produced during these cuts; this indicates that cutting oil in its original form was not present on these chips, and implies that the oil did not penetrate between the workpiece and tool and between the chip and tool from the clearance crevice.

Perhaps the intense heat at the cutting edge and/or the wiping action as the chip passed over the tool were responsible for the elimination of any traces of the fluorescent oil which might have passed under the cutting edge of the tool. However, it does not seem very reasonable that either the heat or the wiping action would have been much more severe at 10 fpm than at 7½ fpm,



which was the highest cutting speed used in the planing tests.

The lowest cutting speed that could be obtained in the lathe tests was 10 fpm, and the highest cutting speed that could be obtained in the planing tests was 7½ fpm. Unfortunately, therefore, it was not possible to conduct tests in both operations which could be correlated directly to each other. However, the cutting conditions were very similar during the removal of the inch-wide chips in the planing operation at a 0.0050 in. depth of cut, with a rake angle of 10½ deg. (clearance angle of 4½ deg.) and in the turning operation at a 0.0050 in. depth of cut with a rake angle of approximately 10 deg. (clearance angle of 6 deg.).

Several turning tests were conducted at a cutting speed of 10 fpm, during which the cutting oil was injected into the rake crevice. No trace of oil was apparent on the workpiece shoulder after any of these test cuts. No attempt was made to introduce the cutting oil into the rake crevice at higher cutting speeds because of the experimental difficulty involved in properly positioning the syringe nozzle between the rake face of the tool and the rapidly forming chip. Since the cutting oil produced no effect on either the chip or surface during the lower speed tests on both the mill and the lathe, it seems unlikely that it would have had any effect at higher speeds where the speed of chip flow would have been even greater.

Conclusions

The results of the planing tests provide conclusive evidence that cutting oil penetrates between the tool and workpiece, and between the tool and chip from the clearance crevice only at the low cutting speeds employed. These results also provide strong evidence that, at very low cutting speeds, cutting oil does not penetrate from the rake crevice down between the tool and the metal which is being cut.

The turning tests gave no indication that cutting oil penetrates between the tool and workpiece or between the tool and chip from either the clearance crevice or the rake crevice at higher cutting speeds.

Several important questions arise naturally from the results of the experiments.

1. *How does the cutting oil penerate between the tool and workpiece and between the tool and chip at very low cutting speeds?* Consideration of this question leads to some plausible conclusions. A certain amount of normal tool vibration occurs during cutting. This vibration might produce a "pumping action" which would force the oil under the cutting edge of the tool from the clearance crevice. The oil then would be pumped partially by the tool and carried partially by the chip into the rake crevice. The cutting edge of the tool is actually irregular from a microscopic viewpoint; therefore, it is possible that during a cut there are many infinitesimal cracks located at random along this edge between tool and workpiece. Oil entering through these cracks would produce streaks of oil between the chip and tool, and not a continuous film. (1) This offers an explanation for the lines of ultraviolet fluorescence observed in the Type 2 portion of the chips pictured in Fig. 7, 8, and 9.

2. *Why does the cutting oil enter from the clearance crevice and not from the rake crevice at very low cutting speeds?* Penetration of the oil between the tool and chip from the rake crevice is opposed by the relative motion of the chip. Penetration of the oil between the tool and workpiece from the clearance crevice is opposed by the relative motion of the workpiece. However, the oil does penetrate to the tool edge from the clearance crevice despite the workpiece motion, but seemingly does not penetrate to the tool edge from the rake crevice. This might be due to the fact that the chip and tool are in intimate contact over a much larger area than are the workpiece and tool. Thus, it is conceivable that the tool vibration and the irregularities of the tool edge as previously suggested would make possible a flow of oil under the cutting edge of the tool from the clearance crevice, but would not make possible a flow of oil under the cutting edge of the tool from the rake crevice. Furthermore, the chip motion over the rake face of the tool, which would hinder the flow of oil from the rake crevice to the tool edge, would aid the flow of oil in the reverse direction. Aside from these general remarks, however, no definite reason for the singular direction of the oil flow at very low cutting speeds can be given at the present time.

3. *Why does the cutting oil flow under the cutting edge of the tool from the clearance crevice at very low cutting speeds, and apparently not at higher cutting speeds?* It is difficult to understand how the cutting speed alone can influence the flow of the cutting oil between the tool and the metal which is being cut, particularly since changes in the cutting speed produce little or no change in the pressures between the tool and chip. (2) A possibility, which might explain the effect of cutting speed, is that the oil passes under the cutting edge of the tool from the clearance crevice when cutting conditions are such that a Type A surface and a Type 1 chip (discontinuous) would be produced, if the cutting were conducted dry. This tendency toward the formation of a discontinuous chip might produce a significantly greater tool vibration which would result in larger gaps between the tool and workpiece and also might provide a greater "pumping action." Another possibility regarding the effect of cutting speed is that there may exist a critical cutting speed above which the oil cannot penetrate between tool and workpiece due to the workpiece motion.

The chip and tool are in intimate contact for a relatively short distance in a direction perpendicular to the tool edge; this distance generally is assumed to be approximately three times the dimension of the uncut chip. Nevertheless, the possibility exists that the cutting oil might penetrate between the tool and the chip from the sides of the chip. There was no apparent experimental method which would allow the application of the cutting oil to the sides of the chip and at the same time prevent this oil from flowing into the rake and clearance crevices. Hence, it was not possible to isolate the effect of introducing cutting oil to the sides of the chip alone. However, it seems likely that the motion of the chip, particularly at higher cutting speeds, would prevent any appreciable penetration of the cutting oil in toward the center of the chip from each side.

The results of these fluid flow experiments support a contention that, although a cutting fluid may provide hydrodynamic or "thick film" lubrication between tool and chip at extremely low cutting speeds, it does not provide hydrodynamic lubrication at higher cutting speeds. However, according to the reports of other investigators (3), the oil may serve as a carrier for the introduction of additives between the tool and chip at higher cutting speeds, thus providing solid lubrication during the cutting process. These additives or reaction products on the chip probably do not respond to the ultraviolet light method which was employed in these experiments. Therefore, it is believed that the existence of additives between the tool and chip should be investigated, possibly by chemical analyses of chips produced in test cuts similar to those discussed in this paper.

Acknowledgement

Grateful acknowledgement is made to Mr. H. P. Flint and Mr. W. S. Power, of Armour Research Foundation, who most ably assisted in conducting this investigation.

[1] A theoretical analysis, "The Role of Cutting Fluid as a Lubricant" by K. E. Bisshopp, E. F. Lype, and S. Raynor, *Lubrication Engineering*, Vol. 6, No. 2, 1950, p. 70, has shown that a continuous fluid film cannot exist between the tool and chip in the sense considered in the usual lubrication theory, although the cutting fluid may occur in minute pockets produced by the irregularities of the rubbing surfaces.

[2] Unpublished data, obtained during the metal cutting research project at Armour Research Foundation, have shown that the resultant tool force remains very nearly constant over a wide range of cutting speeds.

[3] Shaw, Milton C., "Mechanical Activation—A Newly Developed Chemical Process," J. Appl. Mech. Vol. 15, pp 37-44, March, 1948.

THE SEPARATION OF LUBRICATING, COOLING SYSTEMS

by D. P. Morrell
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Mr. Morrell was formerly associated with Vickers, Inc., as Test Dept. Supt., Laboratory Engineer and Liaison Engineer, and was in intimate contact with all types of industrial and aircraft hydraulic components.

He is now associated with the Ford Motor Co. in the capacity of Supervisor of the Fluids and Electrical Section, Manufacturing Engineering Staff.

His responsibilities as supervisor of this section deal with the application of electrical, hydraulic, lubrication and pneumatics in the control and actuation of production machines and equipment on a company-wide staff level.

Inadequate provisions for the separation of hydraulic, coolant and lubricant fluids in machine tools is a major problem confronting all users of high production industrial equipment today. The problem is of major importance in that contamination and mixing of fluids has been the basic cause for a large percentage of machine tool failures. Unfortunately, the average maintenance personnel will quite often repair the damage to the machine without correcting the cause of the breakdown, an open invitation for repeat failures.

The need for separate sealed systems can be emphasized by citing a few recent examples culled from the files. The first is one in which soluble oil contaminated the hydraulic system of a boring machine used to bore the rear axle differential carrier of the Ford V-8. A complaint was received to the effect that, because of sticking control valves, it was necessary to drain and flush the hydraulic reservoir and add new oil every two weeks to maintain production. This had to be done on premium time, a costly and expensive operation.

Test samples taken from a pressure line while the machine was running indicated water contamination of 31% in the hydraulic system. Further examination indicated the coolant was going past the boring spindles into the machine column and thence into the reservoir, that was part of the machine base.

It was necessary to resort to unusual corrective measures on this particular machine, since production schedules would not permit the excessive time loss of a major repair involving the installation of adequate spindle seals. It is also pertinent that the machines were scheduled to be replaced in a few months because of a change in machining the part. Some simple technique for the removal of the contaminating, sludge-producing water was needed. The corrective measure used involved the utilization of the simple principle of preferential wetting. A large area filter was hooked up on a by-pass arrangement. The element of this filter was fashioned of felt and capable of filtering down to 3 micron particle size.

The element, prior to installation, was saturated with clean hydraulic oil. Under operating conditions, oil would flow through the filter and return to the reservoir, by means of the preferential wetting principle. The water, unable to pass through the filter, would accumulate in the filter sump, and was drained daily. The water content was reduced from 31% to 8/10 of 1%. This machine has been operating since without further trouble.

This example is a description of how corrective measures can occasionally be made on existing machinery without undue expense. However, most correctives necessitated by inadequate separation of hydraulic, coolant and lubricating fluids, are time consuming and costly. How costly some corrective measures can be is shown by another example, which is a description of the conditions encountered on several late model crankshaft grinders built by a well-known manufacturer.

The grinders in question use a combined hydraulic and lubrication system with the further complication of coolant and grind dust entering the hydraulic reservoir because of inadequately designed splash guards. As a result of these conditions, the average pump life for the machines is four months. These conditions are being corrected by the installation of separate lubrication systems and a central hydraulic filtration system at a cost of several thousand dollars.

To illustrate the concern of most users relative to combined systems, paragraph HO.6 of the Joint Industry Conference Hydraulic Standards for Industrial Equipment is quoted:

"HO.6—Hydraulic and lubricating systems shall be separated and hydraulic fluids shall not be used to lubricate ways, slides, exposed surfaces, or mechanisms not integral with hydraulic components. When separation is impracticable, the following provisions shall apply:

(A) Combinations utilizing lubricating systems are permissible only if unit pressure is low, operation is infrequent or of an auxiliary nature.

(B) When systems are combined means shall be provided to remove contamination.

(C) Whenever hydraulic and lubricating systems are combined, complete information shall be given on the hydraulic system diagram."

(*Continued on page* 35)

HYDRAULIC ACTUATING AND IN MACHINE TOOL DESIGN*

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Mr. Hoover studied mechanical engineering at the University of Kentucky, and for eight years continued work on the same subject at the Chrysler Institute of Engineering Night School.

He has been affiliated with the Dodge Division of the Chrysler Corp. for 19 years, starting on the assembly line and advancing through machine repairman, machine designer, to his present position as Supervisor in the Master Mechanics Division.

Mr. Hoover has represented his company on the Joint Industry Conference on Hydraulics for Industrial Equipment and has given many talks on the subject.

He is a member of the A.S.T.E. and the American Speakers Club.

The manufacture of lubricating, hydraulic, and cutting oils, today, is a highly technical operation. While millions of dollars have been spent on the development of these specialized products, too little thought has been given to keeping them separated in the machine tool. Each of these products usually does an excellent job, when properly applied, but unfortunately, many of our so-called modern machine tools have no provisions to keep the various fluids separated, with inevitable production loss due to short tool life, scoured bearings, slides and sluggish operation.

More and more, hydraulic power is being used to actuate all types of tools found in a modern machine shop. These tools, for the most part, are working to a very close tolerance and producing parts with a highly finished surface. The slightest malfunctioning of the hydraulic system will, in many cases, immediately show up in the size and finish of the machine parts. The cause of hydraulic failure is not always apparent, in fact, in some instances days and even weeks have been spent trying to locate the trouble.

The value of a hydraulically operated machine tool is judged by its ease of operation, flexibility of feed and speeds, and the quality and quantity of work performed. The full realization of all of the advantages of hydraulic application depends entirely on proper design of the system and the proper selection and care of the hydraulic fluids.

The efficient operation of a hydraulically operated machine requires that the oil be a lubricant as well as the actuating medium. It must be chemically stable, free from acid and non-corrosive, resist emulsification, possess high film strength, correct viscosity and show comparatively little change of viscosity under varying temperature changes.

In the development of a lubricating oil for the bearings, ways, slides and spindles of machine tools, many factors must be considered. The design, speed, pressure, temperature, method and frequency of application, are some of these factors. A good lubricant should do the following:

(a) Maintain a film of oil between the metal surfaces.
(b) Prevent generation of excessive heat.
(c) Dissipate and carry off normal heat created between moving parts.
(d) Remain stable under all operating conditions.
(e) Hold suitable viscosity to the working conditions.
(f) Show economy in operation.

Some of the desirable properties of a good coolant for long tool life are as follows:

(a) Good penetrating characteristics.
(b) Good heat dissipation characteristics.
(c) High film strength.
(d) Low first cost.

From the foregoing it will be seen that no one oil could meet all of these conditions, some will lack certain characteristics contained in others.

In the lubrication of spindles, workheads, multiple-heads, slides, tables and ways on machine tools, many different conditions must be considered. For spindles, high chemical stability is essential, in order to resist formation of deposits. High film strength is an additional requirement. On ways and tables, the high chemical stability of the oil is not the most important factor, but in order to prevent metallic contact, high film strength is of utmost importance.

In a circulatory system suitable means should be provided to filter the oil. Even with the best of filters a certain amount of acids, gums and sludge will be carried back from the bearings and slides into the actuating system. If in some manner, the cooling or cutting compounds find their way into the system, then trouble will develop in the form of sticky slides, tables or ways.

Hydraulic systems, on machine tools, are made up of many components, such as pumps, valves, servo-mechanisms and so forth. Each of these units is held to a very close limit in manufacture, and may not move more than a few thousandths of an inch when in use. Hydraulic actuating fluid therefore must be clean and as free from contaminants as it is possible to keep it. All hydraulic systems should be equipped with a filtering medium to

(*Continued on page* 35)

*Paper presented at 5th Annual Convention of A.S.L.E., Detroit, April 11, 1950.

FRETTING CORROSION IN AIRCRAFT AND AIRCRAFT ACCESSORIES *

by Adolph E. Rahm and Harry J. Wurster

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Mr. Rahm is chief of the Bearing Unit of the Special Projects Branch, Aircraft Laboratory, Engineering Division, Air Materiel Command.

After working in technical field intelligence, he transferred to the Air Force in 1943 as a civilian instructor. In 1945, he was assigned to Wright Field as an aircraft maintenance supervisor, transferring to the Engineering Division in 1946. For the next four years, he set up the Bearing Laboratory and Unit, of which he is now chief.

Mr. Rahm has many years of experience in bearing and component parts specialization, both in the United States and abroad. He received his formal technical education in Switzerland and undertook special studies at Ohio State University and the University of Miami, Florida.

Mr. Wurster was metallurgist for the U. S. Steel Co., Cleveland, where he specialized in ferrous metallurgy. For four years, he was metallurgical research engineer for the Westinghouse Co., Pittsburgh. He specialized in sintered plain metallurgy and plant production metallurgy with the General Motors Corp. for many years.

Mr. Wurster joined the Air Materiel Command in 1948 and is presently specializing in all types of bearings in aircraft and aircraft accessories as a member of the Bearing Unit.

He is a graduate of the School of Metallurgy of the University of Cincinnati.

Historical Data

Within the last several years, "fretting corrosion" or "friction oxidation" has made its appearance in a multitude of machine applications and has been defined as the rapid corrosion that occurs between contacting metal surfaces when subjected to slight relative (vibratory) motions.

Many investigators of the problem pointed out that friction oxidation is perhaps one of the oldest mechanical-chemical problems. However, specific problems arising from "fretting corrosion" have been differentiated from electrolytic and chemical corrosion, or from Prinelling of loaded surfaces within the last two decades only.

One of the most widely known occurrences of fretting corrosion, or friction oxidation developed in the wheel bearings of automobiles shipped by rail from Detroit during the early thirties. This provided the first impetus in the real recognition of the fundamental nature and causes of this problem.

However, it may be stated that while friction oxidation effects were reported in many general applications, of equipment and machinery containing contact surfaces of bearings, it was not until the advent of the modern aircraft, and its accessories that "fret corrosion" problems assumed the magnitude they presently appear to have.

As early as 1936, J. O. Almen reported severe friction oxidation in the inner and outer races of aircraft engine valve rocker bearings and variable pitch propeller thrust bearings. In the succeeding years more and more cases of this phenomenon appeared in aircraft installations.

Friction oxidation caused severe damage on the balls, rollers, and races of anti-friction bearings in airframe control installations, propeller blade stack bearings and in universal joints. Other applications in which considerable damage was reported, were in jet engine bearings after shipment, and when subjected to vibrations during ground rev-up. "False Brinelling" was also reported in large numbers of instrument bearings.

The number of applications in aircraft and aircraft accessories which were affected grew in increasing proportion, and in order to give a comprehensive review of such applications the following list of aircraft installations in which friction oxidation is prevalent may help to depict the magnitude of the problem.

Fixed Wing Aircraft:

aileron hinge point bearings
elevator hinge point bearings
rudder hinge point bearings
flap hinge point bearings
control pulley bearings
universal joint bearings
engine and engine control bearings
propeller and propeller control bearings, housings, and shafts
instrument bearings
accessories

Rotary Wing Aircraft:

rotor head pillow block bearings
blade grip bearings
blade grip thrust bearings
drag and flap hinge bearings
anti-torque drive bearings
transmission bearings
primary control bearings

From the foregoing list it might be assumed that fret corrosion was confined to bearing applications only, however, while aircraft bearing installations bore the brunt of the problem, many cases of "fretting corrosion" in gears, shafts, and housings, splines and in fixed installations are on record. It was found to occur in increasing severity in studs, bolts, and clamps.

The severe loss of dimensional accuracy, and subsequent fatigue failure in structural parts, the destruction of bearing surfaces and the resultant low operational life, in aircraft installations provided the impetus for a very considerable research effort culminating in a number of highly technical research reports. Many of these reports

*The views expressed in this paper are those of the authors only and are not necessarily the opinions of the United States Air Force or the Air Materiel Command.

[1]Paper presented at 5th Annual Convention of ASLE, Detroit, April 12, 1950.

conflict with regard to basic philosophic concepts applying to the problem. All of the reports offered very valuable academic and theoretical data but very few offered immediate practical help. A review of all of the existing data would be unnecessarily tedious and the following summary of literature will suffice to bring the reader up to date with phases of "friction oxidation" studied by the various researchers.

(1) *Vibratory Motion*—appears necessary to produce friction oxidation. The magnitude may be minute (10^{-6} inch). The effect of the amplitude upon the intensity of fretting appears very marked, the effect of the frequency appears to be small

(2) *Oxygen*—is considered necessary. There is every indication to believe that friction oxidation is the more correct term to describe the phenomenon rather than fret corrosion. Fe_2O_3 is considered the product of friction oxidation on steel.

(3) *Welding—Metal Pickup*—This is often confused with friction oxidation, which it should not be. Almen states that relative motion may break welds and lead to friction oxidation.

(4) *Lubrication*—May be cited as the present inadequate method of reducing fretting and friction. It is effective only insofar as it prevents oxygen from reaching the contact surfaces and to the extent it pentrates between the loaded areas. (15).

(5) *Abrasion*—By hard oxides (Fe_2O_3) is a cause of progressive failure and may be a primary reason for the harmful effect of fretting.

(6) *Hardness*—The hardness of one or both steel surfaces is increased in practice to reduce fretting. Contradictory research results have been reported.

(7) *Surface Treatment*—Surface roughness or finish is increased. Here again, contradictory research results are reported. However, reduction of friction oxidation is obtained when using certain surface finishes together with selected lubricants, as will be attempted to show in this paper.

(8) *Design*—In many instances, design appears to have a far reaching influence in mitigating the friction oxidation process and obtaining increased operational life of component parts, as will be noted in this paper.

(9) *Solid Solubility*—and recrystallization temperature, have not been satisfactorily correlated with friction oxidation.

(10) *Materials*—Solid films, cadmium, chrome, lead, silver, gold and graphite, may retard harmful effects but they do not prevent fretting. Friction oxidation has been observed with steel surfaces contacting wood, paper, agate and glass, etc. As a rule, metal combinations appear least susceptible to friction oxidation with the exception of stainless steel which appears most subject to fretting

(11) *Loads*—High loads do not appear to have any direct effect upon the intensity of friction oxidation. Extreme loads may reduce fretting by reducing motion.

(12) *Fatigue Strength* — According to Davies, the fatigue strength of steel was lowered 13-18 per cent by friction oxidation.

(13) *Induced residual compression stress*—It has been reported that friction oxidation is retarded when the contacting surfaces have been treated to induce residual compression stresses.

It is apparent that the basic mechanism of the friction oxidation process has not been perfectly determined and that much research and work will be entailed to obtain this result.

Similarly, the most effective mechanism of action of the reduction of friction oxidation has not been found.

It appeared that a study of the process, in the presence of various design factors, surface finishes and lubrication provisions, might help in establishing means of controlling this phenomenon. If not in the basic elements, then at least in gaining increased operational life for the various component parts in aircraft and aircraft accessories. In addition, the results obtained during service testing of helicopter rotor head thrust and hinge bearings with refined internal tolerances and surface finishes together with certain selected lubricants seemed to point in a corrective direction.

Rotary Wing Experience

At this point it may be well to dwell to some extent upon past experiences with helicopter rotor head main thrust bearings. Friction oxidation caused severe damage on this bearing in operational flight. (See Fig. 1). The total number of flight hours on this application was sixteen. The number of ground test operational hours was 57, accounting for a total of 73 hours. The actual number of operational flight hours was notably short. Very unsatisfactory conditions were observed in helicopter rotor head bearing installations at that time. These may be summed up as follows:

(1) Vibratory loads
(2) Friction oxidation
(3) Poor lubrication
(4) Lack of load carrying capacity
(5) Improperly designed bearing applications

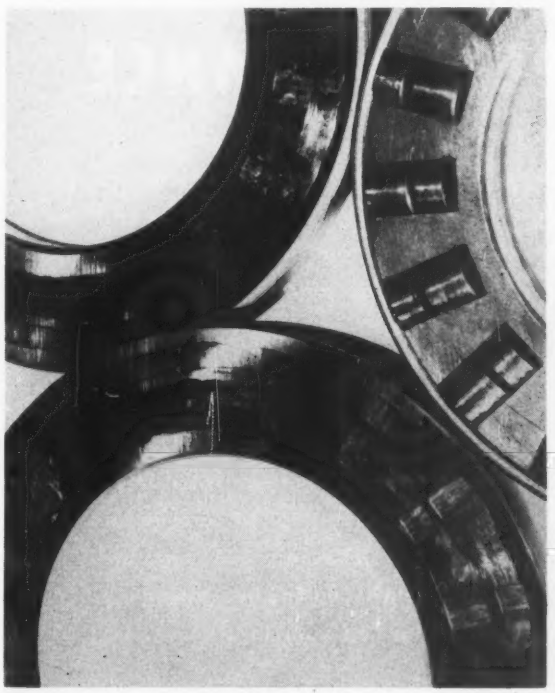

Fig. 1
False Brinelling of Thrust Bearing

It should be noted that bearing failures are usually the result of abnormal conditions such as misalignment, overload, vibration, lubrication, etc. Unless such condi-

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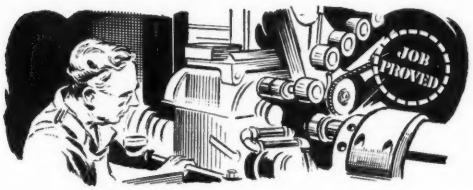

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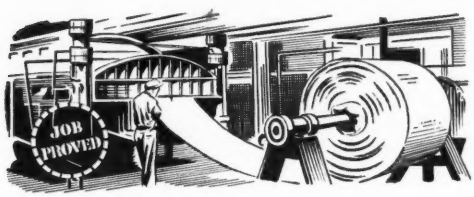

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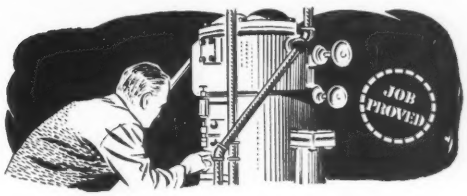
CIRCOMAR-5AA—A dark-colored product for processing natural and GR-S rubber used in tire-making. Also used in reclaiming natural-rubber scrap. Replaces asphalt fluxes. Free-flowing at room temperature.

REFRIGERATION OILS



Hotel turns to Suniso for its ice-making equipment; eliminates separation troubles, cuts oil costs 20%.

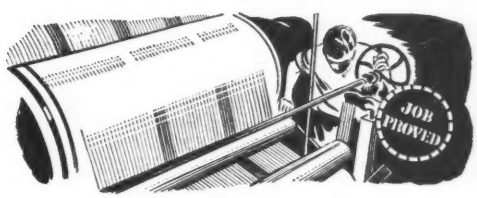
SUNISO REFRIGERATION OILS—High-quality oils having extremely low pour points, extremely low wax-separating characteristics, a high degree of stability, and long life. Initially neutral and resistant to formation of detrimental acids. Suniso grades are available to meet all low, normal, and high temperature conditions. The most widely used oils in refrigerating and air-conditioning.

SUNOCO WAXES

Waxes, "tailor made" to provide the exact properties demanded by different industries, are now available from Sun's new multimillion-dollar wax plant. Revolutionary manufacturing methods make it possible to retain only the wax portions desired for a particular use, while discarding those which might be detrimental.

Sunoco Waxes are precision-controlled for quality and uniformity of *all* physical and chemical characteristics important to the user. The various grades of Sunoco Wax are recommended on the basis of their ability to give superior performance *on the specific job.*

TEXTILE OILS



Sunotex replaces three formula components in textile mill; also saves 25% on costs.

SUNOTEX TEXTILE-PROCESS AIDS—Designed to impart desired additional properties to various fibers during their processing from the raw state into a manufactured product. All Sunotex textile-process aids are emulsifiable in water. Highest rating in Fade-Ometer tests.

SUN COTTON CONDITIONERS—Processing materials which prevent waste by cutting down excessive amounts of fly (fine air-borne lint particles).

SUN ASBESTOS FIBER CONDITIONER—Sprayed on asbestos during processing to keep fibers from being damaged or broken down. Harmful dust is minimized when this product is used.

SUN CORDAGE OILS—Generally used alone, but adaptable to various formulas used by cordage manufacturers. Selected products, highly compatible with additives.

SUNOTEX MACHINE OIL—One lubricant for nearly every kind of textile machine. A high-quality mineral oil and additive combination which prevents rust, clings to moving parts, and minimizes wear. Scours out of *all kinds* of fabrics easily and completely.

ADDITIONAL INDUSTRIAL PRODUCTS

SUN SOLVENTS—Sun Spirits for the thinning of paints, varnishes, and enamels, for metal-cleaning, and certain types of processing and extraction ... a pure, water-white petroleum solvent free of corrosive sulfur. Other Sun solvents with special properties are available for the chemical industry.

SUN LEATHER OILS—Petroleum-base leather oils. Used for obtaining the desired tensile strength, proper temper, and controlled moisture content. Maintain a light even color, mix well, and distribute evenly.

INDUSTRIAL PRODUCTS

SUNOCO®

tions are obliterated replacement of the bearings as such offers no solution to the problem. This hypothesis was most applicable to a particular helicopter rotor head configuration.

The bearing most publicized and perhaps of greatest interest to the reader at this time was the above cited main roller thrust bearing which was flight tested and tested in ground rigs. This was a thrust bearing incorporating 18 sets of double rollers in a bronze cage rolling on flat steel races. The strong discoloration of the rolling surfaces indicated the presence of oxides. Before the overall problem was properly evaluated it was claimed by certain investigators that greases of a particular manufacturer would offer the greatest benefits with regard to increase in bearing life and reduction of friction oxidation. However, neither the service or ground tests showed reduction of friction oxidation through use of a particular make or batch of grease.

The cages showed excessive scoring of the inner diameter. Pocket wear was also noticeable. The oscillation of the rollers was 6°. Eccentric roller travel was indicated in a 1/16" displacement from the true bearing center. The rollers were straight cylindrical types—one short and one long roller to each pocket. Both races showed severe indentures or depressions varying in depth to 0.0002", indicating the existence of combined operational loads. The race discs were carburized.

The general opinion of personnel evaluating this bearing application was that this bearing failed principally because of high unit loads on the end of the rollers which caused the depressions in the races. The following design modifications were proposed for this bearing application in an effort to obtain an immediate temporary solution and increase its operational life.

(1) In place of the flat roller profile, the rollers were crowned to prevent end loading and provide increased roller guidance.
(2) The race material was changed to SA 52100 steel R. C. 62 in place of the case hardened type then in use.
(3) In place of the regular commercial finish, superfinish was employed.
(4) Positive alignment for the roller retainer was provided.
(5) The roller cage was dimpled between the roller pockets to provide for increased lubricant deposition for the adjacent rollers.
(6) The type of bronze from which the cage was manufactured was changed to a high strength type—less subject to distortion.
(7) Lubricant conforming to Specification AN-G-15 in place of AN-G-10 was used. (Based on results of laboratory tests at that time).
(8) The self aligning features of the bearing were crowned.
(9) Housing, bore fits, and locking provisions for the bearings were tightened.

The above design and lubricant changes resulted in considerable improvement in the operational performance and life of this bearing in subsequent service. The present operational life of this bearing is 200 hours.

In view of the foregoing and pending the emergence of a material not subject to friction oxidation to the extent shown by present materials, it was decided to approach this problem from the standpoint of obtaining practical answers for immediate field or service problems. This approach seemed all the more desirable since the perfect lubricant of sufficient film strength and penetrative mobility and all other necessary properties to remain intact between loaded contacting surfaces for an extended time was non-existent.

Experience with a considerable number of bearing installations indicated that much might be gained in looking into the influence of surface finishes, bearing design and construction upon the process of friction oxidation, and the possibility to mitigate the speed of wear by means of design changes, surface finishes and the use of improved AN specification lubricants.

Testing Fixture

In view of the foregoing, a survey of existing friction oxidation testing fixtures or machines was made and their applicability to the problem evaluated. This survey was concluded with the selection of the "Fafnir type" (see Fig. 2) machine as most suitable as far as service needs were concerned.

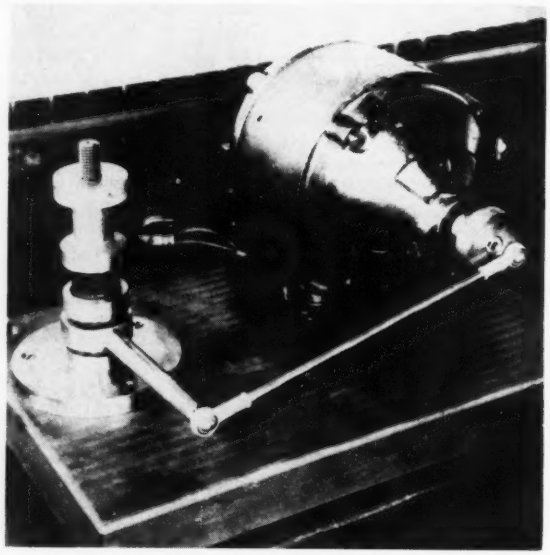


Fig. 2
Fafnir Bearing Co. Friction Oxidation Apparatus

However, experience with the spring loading device showed certain undesirable tendencies and as a consequence a testing fixture was constructed as shown in Fig. 3 and 4. The testing fixture consists of a heavy steel (A) base plate mounted on the table. On this were mounted the bearing seating column (B) which permits the testing of two bearings at the same time, and the loading mechanism (C) consisting of 3 columns and a lever system that permits the application of a 2,000 pound static load (W) by means of 3 roller and 1 ball increment.

The bearings located in column (B) were motivated 3° reversing by arm (D) mounted on the bearing seat (B) and sliding mechanism (E). Sliding mechanism (E) in turn was connected by shaft (F) to the eccentric driver (G) which permitted adjustable degrees of oscillation. Shut off switches (H), (I), and (K) were located on each arm and on the weight. These switches shut off the power in case of arm breakage or bearing failure resulting in lowering of the weight. Power was supplied by a General Electric R.K.T., ¼ hp, AC, 60 cycle, 3 phase, 220 V, 1725 rpm motor. A Brown electronic potentiometer measuring temperature is attached to the bearing seat.

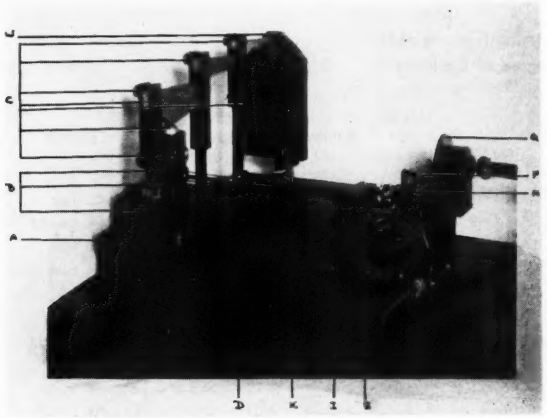


Fig. 3
A.M.C. Friction Oxidation Test Fixture

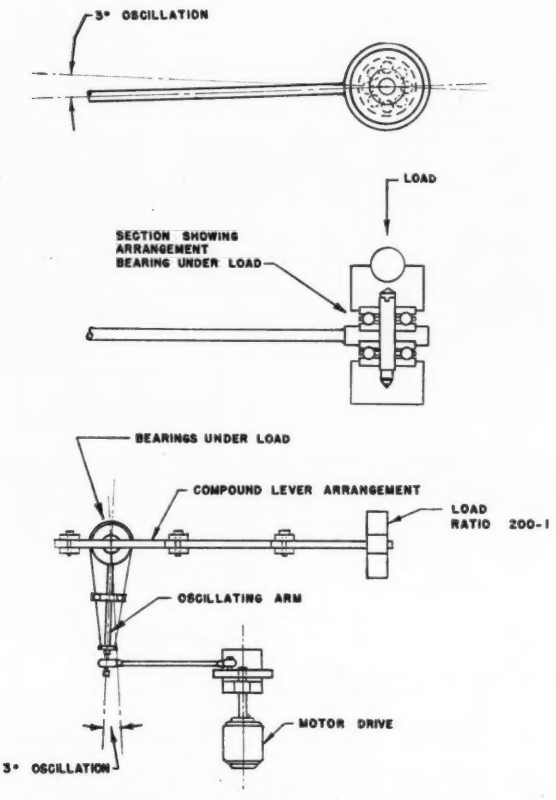


Fig. 4
Schematic Diagram of Fig. 3

Exploratory Tests and General Observations

A considerable number of exploratory tests were run with standard commercial thrust bearings type number 4305. Five different AN lubricants were used and the test machine efficacy evaluated. It became apparent that a number of inconstants originating in the testing process and the bearings would have to be eliminated if repetitive results were to be obtained.

A number of variables were found that apparently influenced the process of friction oxidation. Some of the more important "inconstants" were the surface, the race, the number of balls, the cage type and material and the lubricant quantity and viscosity.

It was also noted that bearings made by manufacturers and supplied to an agent or vendor differed from those the manufacturers supplied direct. The number of balls and the type of cage as well as the surface finish and race groove varied considerably.

It was therefore determined that in future tests all bearings would be of one make, come from one run and have the same number of balls and type of cage. In addition, the surface finish of the race would be held to 4 micro inches and the race curvature to 54 $\pm$ ½ per cent, of the nominal ball diameter.

The tests were to be conducted with several different types of surface finishes and certain selected AN lubricants. A comparison was made between the respective finishes and selected AN lubricants as to their efficacy in reducing fretting.

The benefits derived from vapor blasted bearing surfaces compared to commercial finishes using AN lubricants are listed on Tables 1 and 2. In addition the efficacy of chromized surfaces and molybdenum disulfide lubricant on a commercially finished bearing was shown.

Test Procedure

The following describes the test method and procedure used.

(1) Cleaning: The bearings were washed with cleaning fluid, Specification PS661, and dried.
(2) Hardness: The Rockwell "C" hardness was determined and recorded.
(3) Race Contour: The race contour was measured and recorded.
(4) Surface Finish: The type and micro-inch surface finish of the race was determined and recorded.
(5) Ball Cage: The type, material, and pocket freedom of the ball cage was noted and recorded.
(6) Bearing Balls: The number of balls was noted and recorded.
(7) Cleaning Prior to Test: Rewashed with cleaning fluid PS661 and 50-50 petroleum ether.
(8) Weight of Bearing Prior to Test: Weighed and recorded weight.
(9) Lubricant Prior to Test: Weighed and applied with lubricant to bearing. Recorded the type and weight.
(10) Test:
  a. The bearings were installed in the fixture seats.
  b. A 2,000 pound static load was applied on the bearing (weight W).
  c. The bearings were oscillated through an angle of 3° for 5,000,000 cycles.
  d. The bearings were removed from the fixture.
(11) Cleaning After Test: The bearing was rewashed with cleaning fluid PS661 and 50-50 petroleum ether.
(12) Weight of Bearing after Test: The bearings were weighed and the weight or wear loss recorded.

Test Tabulation Resumé—Table 1

Seventy-one tests were performed using bearings with standard commercial finish. Eighty-two tests were performed using bearings with vapor blast finished raceways. Two tests were made with bearings having a chromized finish surface. Ten different types of lubricants were used in the tests.

The tests indicated that a number of AN lubricants could be eliminated as regarding their efficacy to reduce

TABLE 1

Results of Friction Oxidation Tests

Bearing Race Contour.....54% Static Load.....2000 lbs. Degree of Oscillation.....3° Speed of Motor.....1725 rpm.

Test No.	Thrust Bearing No.	Race Hardness Rockwell "C"	Race Micro Inch Finish	Type of Surface Finish	Type of Retainer	Retainer Material	No. of Balls	Type of Lubricant	Quantity of Lubricant, Grams	Millions of Cycles	Testing Time per Bearing, Hours	Weight Loss of Bearing and Lubricant During Test, Grams	Remarks
3	4305	58–63.5	4	commercial	stamped	brass	10	AN-G-14	1.06	5	50	.0967	Results fair
4	4305	60–63	4	commercial	stamped	brass	10	AN-G-3	1.06	5	50	.0017	Results good
5a	4305	63.5–64	4	commercial	stamped	brass	10	AN-G-5	1.06	5	50	.1424	Results fair
6	4305	59.5–61	4	commercial	stamped	brass	10	VV-O-581	1.06	5	50	.0002	Results very good
7	4305	60.5–61	4	commercial	stamped	brass	10	AN-VV-P236	1.06	5	50	.0212	Results fair
11	4305	63.5–64	4	commercial	stamped	brass	10	AN-G-5	1.06	5	50	.1338	Results poor
22	4305	62.5–63.5	4	commercial	stamped	brass	10	AN-G-25	1.06	5	50	.0066	Results good
23	4305	63–64	4	commercial	stamped	brass	10	AN-G-15	1.06	5	50	.0048	Results good
31	4305	58–59.5	4	commercial	stamped	brass	10	AN-G-10	1.06	5	50	.0027	Results good
37	4305S	62–62.5	4	commercial	formed	steel	8	AN-G-15	1.06	5	50	.0151	Results fair
46	4305S	61.5–62	4	commercial	formed	steel	8	AN-G-25	1.06	5	50	.0016	Results good
66	4305S	62–62	4	commercial	formed	steel	8	AN-G-25	1.06	5	50	.0027	Results good
38	4305	61–62	4	commercial	stamped	brass	10	Molykote	.0700	1.2	12	.0220	Bearing failed
39	4305	61–62	4	commercial	stamped	brass	10	Molykote	.0700	1.2	12	.2916	Bearing failed
28	4305	62.5–63	11–12	chromized	stamped	brass	10	AN-G-25	1.06	2	20	.0011	Bearing failed
29	4305	63–63	11–12	chromized	stamped	brass	10	AN-G-25	1.06	2	20	.3477	Bearing failed
110	4305S	62–62	5–6	vapor blast	formed	steel	8	AN-O-8		5	50	.0004	Results very good
116	4305	61–62	5–6	vapor blast	stamped	brass	10	AN-G-25	1.06	5	50	.0020	Results good
128	4305S	59–61	5–6	vapor blast	formed	steel	8	AN-G-25	1.06	5	50	.0035	Results good
129	4305S	60–61	5–6	vapor blast	formed	steel	8	AN-G-15	1.06	5	50	.0048	Results good
146	4305S	60.5–63.5	5–6	vapor blast	formed	steel	8	AN-G-15	1.06	5	50	.0037	Results good
148	4305S	62–63	5–6	vapor blast	formed	steel	8	AN-O-8		5	50	.0001	Results very good
149	4305S	62.5–63	5–6	vapor blast	formed	steel	8	AN-O-8	Submerged in oil	5	50	.0005	Results very good
150	4305S	62.5–63.5	5–6	vapor blast	formed	steel	8	AN-G-25	1.06	5	50	.0021	Results good
151	4305S	63–63	5–6	vapor blast	formed	steel	8	AN-G-15	1.06	5	50	.0020	Results good
152	4305S	61.5–63	5–6	vapor blast	formed	steel	8	AN-O-8		5	50	.0028	Results good
153	4305S	63–63.5	5–6	vapor blast	formed	steel	8	AN-O-8	Submerged in oil	5	50	.0018	Results good

friction oxidation. The results of the tests as shown in Tables 1 and 2 indicate that AN-G-25 grease, AN-G-15 grease and AN-O-8 oil had lubricating characteristics which offered greater resistance to friction oxidation than other lubricants tested during exploratory tests. The bearings with the vapor blast finish in combination with the above three cited lubricants produced the best results. The lubricant "retention-ability" of the vapor blast surface contributed to the decrease in wear or weight loss as shown by the test results.

It is possible that the vapor blasting process induces, in addition to creating a uniform lubricant retaining finish, infinitesimal residual compression stresses. This would account for the reduction-in-wear-loss on the vapor blasted bearings as compared to the commercially finished types.

Although AN-G-25, the grease which had the best friction oxidation qualities, was used with the chromize finished bearings, it is to be noted that this finish did not help in reducing friction oxidation. On the contrary, it appeared to intensify the process. The weight loss was 0.0011 gram and 0.3477 gram, respectively, and the bearings completed only 2,000,000 cycles. Commercial finish bearings and vapor blasted types completed 5,000,000 cycles.

The commercial finish bearing in which dry molybdenum-disulfide was tested as a lubricant showed the poorest results. It failed after completing 1,200,000 cycles. While molybdenum disulfide appears to have qualities that induce slippage when used on housings, or plain surfaces, it does not appear to possess any mitigating qualities to reduce friction oxidation in ball bearings subjected to small angle oscillation when used in a dry powder form.

TABLE 2

Average Weight or Wear Loss of Bearings Comparison of Lubricant and Finish Effectivity

No. of Tests	Type of Finish	Type of Lubricant	Average Weight or Wear Loss in Grams	Weight or Wear Loss Differential in Grams	Decrease in Wear Due to Lube.	Decrease in Wear Due to Finish
25	Commercial	AN-G-25	.0039			
25	Commercial	AN-G-15	.0065	.0026	40%	....
25	Commercial	AN-G-25	.0039			
24	Commercial	AN-O-8 oil	.0012	.0027	69%	....
25	Commercial	AN-G-15	.0065			
24	Commercial	AN-O-8 oil	.0012	.0053	80%	....
25	Commercial	AN-G-25	.0039			
22	Vapor Blast	AN-G-25	.0028	.0011	....	28%
25	Commercial	AN-G-15	.0065			
27	Vapor Blast	AN-G-15	.0048	.0017	....	26%
24	Commercial	AN-O-8 oil	.0012			
25	Vapor Blast	AN-O-8 oil	.0012	.0000	....	0
22	Vapor Blast	AN-G-25	.0028			
27	Vapor Blast	AN-G-15	.0048	.0020	42%	....
22	Vapor Blast	AN-G-25	.0028			
24	Vapor Blast	AN-O-8 oil	.0012	.0016	57%	....
27	Vapor Blast	AN-G-15	.0048			
24	Vapor Blast	AN-O-8 oil	.0012	.0036	75%	....

Table No. 2 strikingly illustrates the reduced wear or weight loss accruing from a combination of surface finish and grease. The efficacy of the vapor blast finish

(*Continued on page* 40)

"That's like running machinery without the RIGHT

PENOLA LUBRICANT!"

Be Sure—Specify Penola: Engineered for industrial efficiency ...High-quality lubricants for high-quality protection

TECHNICAL ASSISTANCE: Our staff of expert lubrication engineers are ready to help with *your* lubrication problems. Contact our office nearest you.

Penola Oil Company
NEW YORK DETROIT
CHICAGO ST. LOUIS

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NEWS OF THE SECTIONS

NEW YORK

HISTORY

The organization meeting of the Section was held in the New York Athletic Club, October 22, 1945, with 14 in attendance. On November 7th of the same year, formal authorization was granted by the then President, C. E. Pritchard.

This group has maintained a steady growth with present membership in excess of 200, making it the largest Section in our group of 23.

The New York Section acted as hosts for the 4th Annual National Convention of ASLE and the 2nd Lubrication Show held in their city in 1949.

May the next five years, show for the New York Section, as much growth and steady progress as has been evidenced since their organization.

CHICAGO

By L. B. Burt, Vice Chairman

Abstract—"Reclamation of Industrial Petroleum Products" by Dean M. Cleaveland, Bendix Products Div., Bendix Aviation Corp., South Bend, Ind.

Reclamation of Industrial Petroleum Products is nothing more or less than a salvage operation, whereby a contaminated petroleum product which has lost its usefulness in plant operation is restored to its original usefulness by removal of contaminates.

These contaminates fall into four general classifications:

1. Solids, such as steel chips, etc., in cutting oils and lubricating oils.
2. Liquids, such as solvents, moisture, etc., in cutting oils and lubricating oils.
3. Insoluble colloids, such as sludges and certain emulsions.
4. Soluble contaminates, such as acids, aldehydes, keytones, and polymers thereof, which are oxidation products.

The first classification of contaminates can be satisfactorily removed by filtration, either capillary or pressure, depending on the degree of purification desired.

The second classification requires both filtration and distillation to restore the products to their original usefulness.

The third and fourth classifications require chemical treatment, filtration and distillation to render the products suitable for further use.

Reclamation of petroleum products can be most profitable if properly planned and operated. However it is recommended that personnel thoroughly familiar with your plant and its particular operation be assigned to make a careful plant survey relative to reclamation possibilities before embarking on any program of reclaiming industrial petroleum products as the wrong equipment and program will produce very disappointing results.

CINCINNATI

By W. D. Whalen, Chairman, Section News Committee

J. Howard Groom, Field Service Engr. of the Cincinnati Milling and Grinding Machine, Inc., discussed "The Maintenance and Servicing of Hydraulic Units for Machine Tools" at the December meeting.

Liquids being practically incompressible have a unique advantage in the transmission of power and in the control of machine elements and cycles.

Modern machines combine hydraulic with electrical circuits for control of automatic cycles. The circuits may become complicated so that the maintenance man must be alert to determine which circuit needs attention in case of operating difficulties.

Hydraulic units are made with a high degree of precision and if a program of preventative maintenance is maintained they will give long and satisfactory service.

A prominent builder of hydraulic equipment made an analysis of their service calls and found the following causes for such calls:

1. 70% due to improper condition of the hydraulic oil.
2. 10% due to improper diagnosis of trouble or lack of "know-how" in making repairs.
3. 10% due to mechanical failures such as bearing failures from misalignment, seal failures due to dirt, etc.
4. 5% due to operating units beyond recommended limits of speed, pressures or volume.
5. 5% due to miscellaneous causes such as, excessive packing friction, inadequate way lubrication, etc.

BALTIMORE

By A. E. Cichelli, Chairman
Program and Meetings Committee

"Bearing Metals, Their Properties and Uses," by H. L. Smith, Executive Tech. Engr., Federated Metals Div., American Smelting and Refining Co., Pittsburgh, Pa. Mr. Smith indicated that over 400 bearing alloys have been reduced to six with the net effect being improved performance where these six are applied properly. The six bearing alloys referred to have been given A.S.T.M. designations of Nos. 2, 3, 7, 8, 14 and 15. Nos. 2 and 3 are tin babbitt with varying percents of antimony and copper. Nos. 7 and 8 bearing alloys are lead babbitt without arsenic, Nos. 14 and 15 are lead babbitt with arsenic.

Further, in applying babbitt metals to bearings it is important to understand that there are four major bearing classifications. In other words, once a bearing application has been properly catalogued into one of these four classifications, one can make a proper babbitt recommendation with little difficulty. Bearing classifications are these: a) Precision, under 8" in diameter such as automotive and diesel engines. b) Large diameter flood lubricated precision bearings such as roll neck and turbine bearings. c) Medium bearings such as are used in pumps, compressors, and motors and mill tables. d) Fourth class are all loose fitting bearings such as old type roll neck bearings, old style roll table bearings, etc.

There is no reason to design bearings with over 3/16" babbitt thickness inasmuch as the resistance to fatigue property is materially decreased as the thickness increases. In fact on diesel engine bearings, thicknesses in the order of .010 proved very satisfactory. As the bearing thickness increases, compressive strength together with ductility and hardness become the important physical properties. Lead arsenic babbitts are superior in every respect and cheaper than tin babbitts. The only excuses for using tin babbitts in the author's opinion, are either poor foundry practice or poor bearing design. By poor foundry practice he meant improper bonding and improper attention paid to temperatures during the pouring and setting up of the babbitt. He pointed out that due to the plasticity of tin babbitt, it could withstand the bad effects of poor bonding far better than lead babbitts.

(*Continued on page* 37)

NEW PRODUCTS and EQUIPMENT

TRANSFER PUMP: Announcement is made of a new high speed, air-operated transfer pump. Model No. 82230 transfers fluids at 22 gals. per minute. It empties a 55 gal. drum of S.A.E. 30 oil in slightly over two minutes. It can be used for transferring lubricants, thinners, coolants, and other materials. The Speed-Flo transfer pump fits on 2" opening drums. It has a built-in, disc-type, precision-flo regulator to permit finger-tip regulation of the volume of output. Weight 18 pounds. For complete information write for Bulletin No. 213.

Lincoln Engineering Co., 5743 Natural Bridge Ave., St. Louis 20, Mo.

MULTI-PURPOSE GREASE: A new oxidation inhibited multi-purpose grease, Cosmolube, which is said to meet practically all the grease needs in the average industrial plant, is now available. The manufacturer announces such outstanding features as resistance to high heat, cold or wet conditions, excellent oxidation stability, and extreme adherence ability. Cosmolube is a cold-milled grease and is available in two consistencies, NLGI No. 1 and No. 2. Write the manufacturer for further details.

E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

"COLLECTIVE VOLUME II": This is a compilation of data on several new chemicals which have become available from the company's research laboratories during the last year. Copies of this bulletin may be obtained by writing the New Products Division.

American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y.

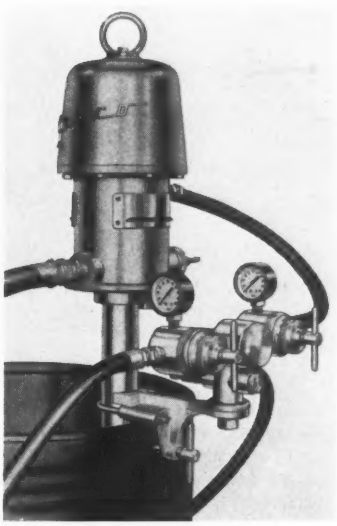
FOG LUBRICATOR: A new principle in oil fog lubrication is announced by the manufacturer who claims the basic advantages are: Increased carrying distance of mist, uniform distribution through several outlets, offers more thorough lubrication at minimum air flow, precision control of oil flow, fully automatic and features visible oil feed and supply. This device is applicable for multiple units in simultaneous operation.

The lubricators are available in models to function over the complete range of 1 cfm to 10 psi up to 14 cfm at 80 psi. Altogether eight models are offered with variable bowl capacities. All are equipped with sight feed and visible oil supply and are completely automatic. Additional data is available by writing the manufacturer.

C. A. Norgren Co., 222 Santa Fe Drive, Denver 9, Colo.

RUST PREVENTIVE: Solvent type, organic metal preservative, Saf-film rust preventive was especially developed for the protection of highly finished surfaces, parts and equipment prior to storage or shipment. It is fast drying with the film removable with kerosene or solvent. It is said to form a tough elastic polar film with the ability to resist acids, alkalies and abrasion. Product data sheet and technical literature available upon request.

Swan-Finch Oil Corp., RCA Building West, New York 20, N. Y.



POWERFLO PUMP: The manufacturer claims that with the introduction of the new Mogol-Type Powerflo Pump, spray gun spurting is completely eliminated. This air-operated high volume material handling pump is equipped with a device called the Evenflo, which enables the user to coat surfaces evenly to meet rigid specifications.

The pumps operate in the original 400-lb. and 100-lb. drums or in bucket-type containers. They operate within a broad air pressure range from 20 to 175 psi, and can be operated by air compressors with either large or small output capacities. For additional information write the manufacturer.

Gray Company, Inc., Minneapolis 13, Minn.

(*Continued on page* 32)

THE BROWN COMPANY, Quality Paper Makers of Berlin, New Hampshire, says: "In seven months —

This Lubricant saved us $2,098.16

"During the seven month period before using LUBRIPLATE No. 130AA in the bearings of our Kraft Mill Lime Kiln, we used a conventional oil of the density recommended. The cost of the lubricant for the period was $2,134.00. In the seven months that followed, we only used 128 lbs. of LUBRIPLATE No. 130AA for initial filling and replacement at the cost of $35.84. LUBRIPLATE No. 130AA only requires weekly applications whereas the former lubricant required daily application."

• • •

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(*Continued from page* 31)

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WINDOW UNIT: A 4-page bulletin describing a one-piece window to indicate liquid level, flow, drip or movement of internal parts, is announced. The unit is flush-mounted by simple press fit, preserving the clean-lined machine surface. Uses developed by designers to solve various problems are described.

Bijur Lubricating Corp.,
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SUN OIL BOOKLET: "Doing Right by Your Hydraulic System" is a cartoon-illustrated practically written pocket-size booklet aimed to help foremen and operators protect vital equipment. Material is reprinted from Sun's latest technical bulletin "Hydraulic Fundamentals and Industrial Hydraulic Oils."

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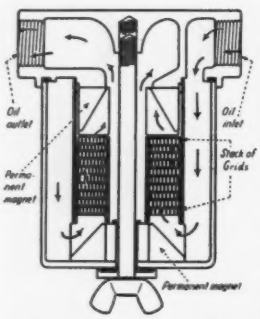
extracts steel and iron particles from suspension in oil — even as small as a micron in size



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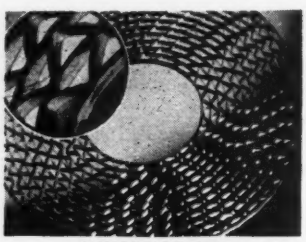

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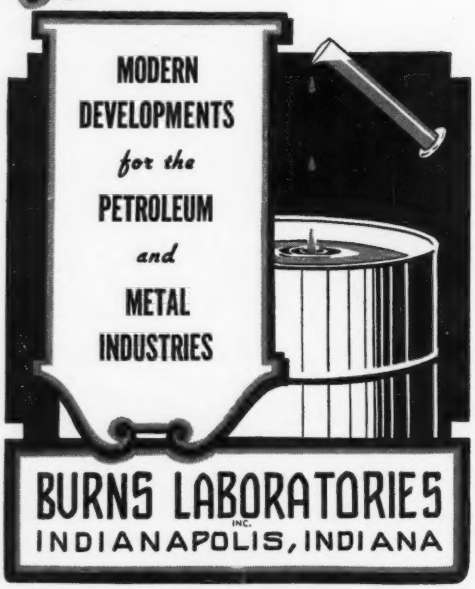

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THE SEPARATION OF LUBRICATING, HYDRAULIC ACTUATING AND COOLING SYSTEMS IN MACHINE TOOL DESIGN

by D. P. Morrell

(*Continued from page* 20)

In conclusion, it should be reiterated that the industrial equipment user cannot tolerate combined fluid systems, either by accident or by design. Combined hydraulic and lubrication systems result in excessive contamination and oxidation of the hydraulic fluid, and quite often the oil used does not have the correct properties for both hydraulic and lubrication types of service. Combined hydraulic oil and tool coolants result in excessive sludging and sticky controls. All of the conditions described add up to excessive downtime and excessive production loss with the attendant higher cost per unit to the consumer.

It should be pointed out that, fortunately, more and more machine tool builders are realizing that a good machine tool is something that is engineered, not only to turn, cut or form a part within certain limits, but is also designed for maximum service life by the incorporation of a sealed separate lubrication system, a sealed separate hydraulic system and a sealed separate coolant system, with all components readily accessible for servicing.

by O. E. Hoover

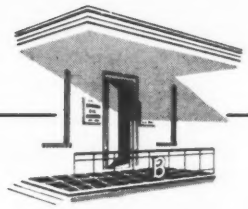
(*Continued from page* 21)

keep the oil, as far as is possible, in its original condition.

While it is recognized that some hydraulic oils are good lubricants, in most cases, it has not been economical to combine the two systems. In fact, one large corporation has spent thousands of dollars to separate the two systems on their machine tools.

When hydraulic fluids are used for the dual purpose of lubrication and the transmission of power, there is a tendency to a faster break-down of the fluid. The hydraulic fluid being exposed to the air, dirt and coolant on the ways and slides become contaminated and this contamination is then carried back to the hydraulic tank, where it is picked up by the pump and recirculated through the controls; and dirt, sludge or coolant in the hydraulic fluid will cause the controls to function improperly, thus causing machine down time. Even though the hydraulic fluid is not returned to the actuating system, it is dissipated in most cases, into the cooling system. This in turn causes increased tool cost and also, due to stream polution, creates a disposal problem.

In conclusion, it should be pointed out that the separation of hydraulic, lubricating and coolant systems is the machine tool designer's responsibility and should be accepted as such. In too many cases, the users of the equipment have been forced to separate the coolant, hydraulic and lubricating systems to make the machine tool function as intended and to maintain production schedules.



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Program Outline

A.S.L.E. NATIONAL CONVENTION

The Bellevue-Stratford Hotel, Philadelphia

APRIL 16, 17, 18, 1951

Monday, April 16

9:00 A.M. — Registration
11:00 A.M. — General Society Business Meeting
2:15 P.M. — Opening Technical Session

SESSION 1

"Planned Lubrication in IBM"
By W. L. Lewis, Vice President, International Business Machine Corp., Endicott, N. Y.

"Lubrication, Its Importance to Plant Fire Safety"
By Ridgely G. Shepherd, Textile Engineer, Standards Department, Factory Mutual Engineering Division, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

"Storage and Distribution of Lubricants"
By O. M. Albl, Tapco Division, Thompson Products Co., Cleveland, O.

Tuesday, April 17

9:00 A.M. to 12:00 Noon—Two Concurrent Sessions

SESSION 2A

"Lubrication in the Textile Industry"
By K. M. Lowry, Manager, Industrial Engineering Department, Deering Milliken, Greenville, S. C.

Discussors:

1. F. K. Fogleman, Technical Writer, Textile Machine Works, Reading, Pennsylvania.
2. Bruce M. Dunham, Technical Consultant, Industrial Products Department, Sun Oil Company, Philadelphia, Pa.
3. Oliver A. Johnson, Lubrication Eng., Saco-Lowell Shops, Biddeford, Maine.
4. Raymond E. Getchell, Chief Engineer, B. F. Perkins and Sons, Inc., Holyoke, Mass.

SESSION 2B

"Adventures in Lubrication"
By Donald F. Wilcock, Section Engineer, Bearing and Lubricant Center, General Electric Company, West Lynn, Mass.

"Oil Deterioration in Theory and Practice"
By R. G. Larsen, Manager, and H. Diamond, Chemist, Lubricants and Fuels Department, Shell Development Company, Emeryville, Cal.

"The Mechanism of Grinding and the Function of the Lubricant"
By John O. Outwater, Field Engineer, E. I. du Pont de Nemours & Company, Wilmington, Del.

2:15 P.M. to 5:00 P.M. — Two Concurrent Sessions

SESSION 3A

"A Study of Rust Preventive Properties of Greases"
By R. J. Burger, B. Rubin & E. M. Glass, Materiels Laboratory, Engineering Division, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, O.

"High Temperature, High Speed Grease Applications"
By E. H. Erck, Lubrication Engineer, Eclipse-Pioneer Division, Bendix Aviation Corporaton, Teterboro, N. J.

SESSION 3B

"Evaluation of Lubricating Properties of Drawing Compounds"
By Wesley J. Wojtowicz, Vice President and Director of Research, H. A. Montgomery Company, Inc., Detroit, Mich.

"Automotive Drawing Compounds Characteristics and Application"
By James T. O'Reilly, Supervisor, Manufacturing Research Department, Ford Motor Company, Dearborn, Mich.

"Some Problems Encountered in the Use of Soluble Oils"
By A. W. Lindert, Group Leader, Industrial Lubricants Research Dept., Standard Oil Company of Indiana, Whiting, Ind.

Wednesday, April 18

9:00 A.M. to 12:00 Noon — One Session Only

SESSION 4

"Liquid and Vapor Phase Corrosion Inhibitors"
By H. R. Baker and W. A. Zisman, Lubrication Branch, Chemistry Division, Naval Research Laboratory, Washington, D. C.

"The Nature and Use of Petroleum Base Rust Preventives"
By H. B. Carpenter, Sales Engineering Division, Esso Standard Oil Company, New York, N. Y.

"Wire Rope Lubricants and Lubrication"
By John P. Critchlow, Chief Fuels and Lubricants Engineer, Rolling Mill Section, Gulf Oil Corporation, Pittsburgh, Pa. and Roland W. Flynn, Staff Engineer, Gulf Oil Corporation, New York, N. Y.

2:15 to 5:00 P.M. — One Session Only

SESSION 5

Internal Combustion Engine Panel (Marine, Railroad, Stationary, Bus and Truck—Diesel and Gasoline.)

SUBMIT QUESTIONS IN ADVANCE BY WRITING THE CHAIRMAN OR FROM THE FLOOR.

Chairman:

Dr. Wilson P. Green, Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

Panel Members:

A Representative of Detroit Diesel Engine Division, General Motors Corporation, Detroit, Mich.

George Stevens, Worthington Pump and Machinery Corp., Buffalo, N.Y.

C. A. Rosen, Caterpillar Tractor Company, Peoria, Ill.

W. King Simpson, Electro-Motive Division, General Motors Corporation, La Grange, Ill.

W. J. Pelizzoni, International-Plainfield Motor Company, Plainfield, N. J.

G. A. Round, Socony-Vacuum Oil Company, Inc., New York, N. Y.

K. L. Hollister, The Texas Company, New York, N. Y.

W. A. Wright, Sun Oil Company, Marcus Hook, Pa.

A.S.L.E. Luncheon — Monday 12:30 P.M. — Speaker to be announced

A.S.L.E. Annual Banquet — Tuesday 7:30 P.M. — Speaker to be announced

Breakfasts For Authors and Chairmen—Tuesday and Wednesday—7:30 A.M.

Plant Inspection Trip, Atlantic Research Laboratories Wednesday—9:00 A.M.

NEWS OF THE SECTIONS

(*Continued from page* 30)

There is no method of cleaning other than the salt bath process that will adequately prepare cast iron shells for babbitting. Referring to foundry practice, Mr. Smith did not believe in stipulating definite temperatures. Instead, he set a rule of thumb to the effect that after pouring, a steel rod should be used to stir the babbitt and make sure that it doesn't set for less than a minute after pouring. This tends to prevent segregation and expansion and contraction effects caused by early freezing.

KINGSPORT

By E. L. Forbes, Acting Secretary

Two movies were shown at the December meeting of this section which were excellent for the occasion. The first, "The Story of Lubricating Oils," showed the development of the petroleum field from the first crude drilling equipment and technique, through the modern equipment and technique.

The second movie, "The Story of Lubricating Oils," illustrated the research and development work and the results accomplished to give us the high quality lubricating oils which we enjoy today. The efforts in research and development to give suitable lubricant for any application was aptly demonstrated.

BOSTON

By A. S. McNeilly, Secretary

Dr. M. E. Merchant, Cincinnati Milling Machine Company and Midwestern Vice President of ASLE delivered his very excellent talk on cutting fluids and the mechanism of metal cutting. Dr. Merchant has the ability to couch in simple terms an extremely complicated subject.

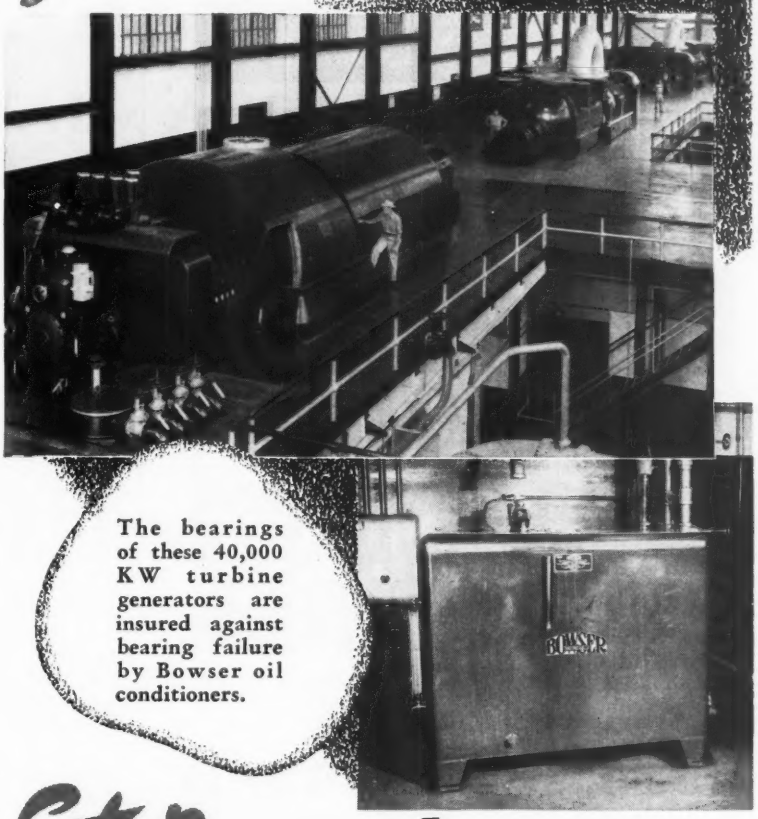
PHILADELPHIA

By William Eismann, Jr., Secretary

"Lubrication of Textile Machinery" by Bruce Dunham, Technical Consultant, Industrial Products Dept. of the Sun Oil Co. Mr. Dunham has spent several years in making a survey of the textile industry, and thus was equipped to provide a rather complete story with numerous slides, illustrating the lubrication requirements and practices of nearly all types of textile machines. It was rather startling to learn that the textile industry, generally considered to be the third largest industry in the

(*Continued on page* 39)

Longer life for Turbine Bearings



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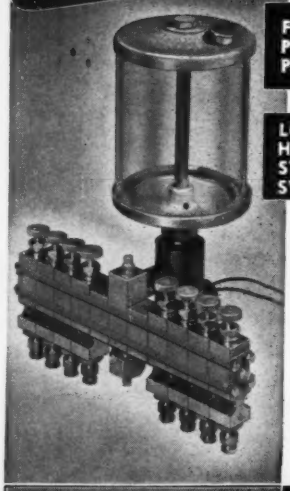

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A.S.L.E. MEMBERSHIP CLASSIFICATIONS

Membership in the Society is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

MEMBERS—$12.50

Members shall be: (1) persons not less than twenty-four years in age who are engaged in research and instruction at technical schools, universities and various publicly and privately supported institutions in the field of lubrication: or (2) persons not less than twenty-four years in age who have occupied recognized positions as Lubrication Engineers for a period of three or more (not necessarily consecutive) years prior to date of admission, involving the responsibility for or supervision of the development, selection, field use and application of lubricants as differentiated from other activities: or (3) persons not less than twenty-four years in age who are indirectly concerned with the field of lubrication, but possessing other qualifications of experience, knowledge and accomplishment, have manifested a particular interest in the purposes and welfare of the Society, to the extent that their membership would be a valuable contribution to the successful functioning of its activities.

ASSOCIATE MEMBERS—$6.25

Associate Members shall be: persons less than twenty-four years in age, and those who do not completely fulfill the membership requirements for Members.

SECTIONAL SUSTAINING MEMBERS—$25.00

Sectional Sustaining Members are such persons or organizations as may be interested in and desire to contribute to the support of the purposes and activities of a local Section of the Society.

INDUSTRIAL MEMBERS

Industrial members are such persons or organizations as may be interested in and desire to contribute to supporting the purposes and activities of the Society. The fees paid by an industrial member in general will not be allowed to exceed $200.00 per year.

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(*Continued from page* 37)

country, has the fewest lubrication engineers. When one considers the number of lubricant applications required in an average textile plant, it would appear that our Society should be able to render valuable assistance to this industry.

YOUNGSTOWN

By M. C. Jones, Secretary

"Through the continued cooperation of the oil companies, industries may realize greater savings in cost production," L. W. Deutsch, Sales Mgr. of the Trabon Engineering Corp., told members of this section at their December meeting. "Industrial management has caused machine tool builders to equip centralized lubricating systems at the point of manufacture," said Deutsch. "This is evident by a 30 percent increase in the use of centralized systems during the last year."

ST. LOUIS

By O. Wulfert, Chairman

"Lubrication of Steel Plants" by C. E. Pritchard, Chief Lubrication Engineer, Republic Steel Co., Cleveland, O. Mr. Pritchard indicated that his organization recognized the importance of lubrication and had efficiently placed a lubrication program into effect. The lubrication engineer and the lubrication supervisors of various divisions are given proper recognition and authority to make certain that the specified lubrication procedures are followed. Repair shops in which lubrication equipment and records are stored and maintained are located in various divisions.

The lubrication supervisors are expert mechanics and have equal rank with other operating supervision. These lubrication supervisors report to the plant manager and the chief lubrication engineer acts in an advisory capacity.

The author explained the savings which occur with proper lubrication management including the reclaiming of oils, coolants, etc. An interesting feature was in separating the process lubricants, etc., from the water. It was possible to save 2/3 of the water which was previously wasted.

Appropriate slides were shown of the application of lubrication to steel making equipment.

BUFFALO

The December meeting consisted of a Symposium on Bearings and Lubrication. Ken McHenry acted as Moderator. Many questions were discussed and the meeting was an informative one. The subject presented at the January meeting was on Automotive Lubrication.

FORT WAYNE

A discussion on the use of propane as a motor fuel was ably handled by Robert S. Lee, Assist. Sales Mgr. of the Twin Coach Co., Kent, Ohio, and John A. Popp, Mgr. of the Sun Oil Co., Sales Division, at a recent meeting of this section. The talks were followed by a long session of questions and answers which showed the interest in the use of propane as a motor fuel.

Russell L. Gruenert, a representative of the Bijur Corp., with a background of 18 years in the lubrication field, presided at the January meeting. His talk and slides covered lubrication devices, their value, limitations and application of a lubrication system to a machine tool.

FRETTING CORROSION IN AIRCRAFT AND AIRCRAFT ACCESSORIES

(*Continued from page* 28)

in conjunction with AN-O-8 oil is outstanding as compared to greases. When used in conjunction with AN-C-25 the vapor blasted finish showed reduced wear loss, as did AN-G-15, as compared to commercial finish.

It appears that the lubricant retention characteristic of the vapor blasted finish helped to maintain a lubricant film between the balls and the raceways. Therefore, this finish used in conjunction with a grease of high mobility and film strength should produce extended operational service life of the bearings or component parts. From the tests to date it is indicated that surface finish, and the correct lubricants are important factors in reducing friction oxidation together with proper design considerations.

Evaluation of the test results as shown in Tables 1 and 2 indicates that obtaining constant results hinges on the elimination of test variables.

Conclusions

From the results obtained, it is clear that neither greases, surface finish, nor design factors as such represent a solution for the problem of friction oxidation. However, a combination of the best factors of all three may result in a substantial increase of operational life time of grease lubricated bearings and component parts in aircraft and aircraft accessories.

It should be realized that all that has been done to date, is "buying time" in a manner of speaking. As stated before, the perfect solution would be a material not subject to wear, a suitable lubricant not subject to deterioration, and ideal design conditions.

Future Considerations

The need for immediate practical answers to service friction oxidation problems in aircraft and aircraft accessories led to the initiation of the foregoing tests. The encouraging results of the tests to date have widened the project and the program has been enlarged for future testing of bearings having various specific surface finishes and design modifications in conjunction with selected AN specification lubricants.

It is planned to test a sufficient number of bearings, lubricants, and surface finishes to ascertain the most beneficial combination yielding increased operational life. It is hoped that the conclusion of the program, a surface and an AN specification lubricant having the most advantageous characteristics for combating friction oxidation and increasing operational life can be standardized upon and used until such time as a more perfect solution to the problem is found.

APPENDIX A
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CURRENT LITERATURE

American Chemical Society — 118th Meeting, Chicago, Sept. 3-8, 1950 (Abstracts of Papers)

THE MECHANICAL BREAKDOWN OF SOAP-BASE GREASES

Moore, R. J. and Cravath, A. M.—p. 140

The breakdown of both commercial and experimental greases were studied, including calcium, barium, hydrous soda, multipurpose soda, and multipurpose lithium-base greases, all of which show fiber breakage to a greater or lesser extent depending upon the particular soap used. In the case of the multipurpose sodium-base grease, the initial fiber breakage was followed by extensive longitudinal shredding of the fiber fragments, which gave rise to an increase in consistency during use. Subsequent breakage of the finer fibers on continued shearing led ultimately to complete loss of greaselike structure. In the simpler cases the change in consistency, expressed as the reciprocal of the penetration measured with a light weight simple cone, was found to be a linear function of the logarithm of time of shearing. A similar linear relationship is found for other mechanical breakdown processes, notably the degradation of high polymer solutions by shearing, and a theoretical basis for this law has been derived.

Chemical Engineering, Vol. 57, No. 11, November, 1950

OIL-AIR VAPOR SYSTEM DEVELOPED FOR ALL KINDS OF MACHINE BEARINGS

Olive, T. R.—p. 172

Continuous, controlled lubrication for almost any group of machine bearings can be handled economically, it is claimed, by the new Oil-Mist system of lubrication introduced by the Alemite Division of Stewart-Warner Corp. In this system oil is atomized by means of compressed air and the finer particles are separated out in the lubricator for transmission by a flow of air through small pipes to the point of use. These particles are so fine that they stay in suspension indefinitely and are consolidated as a lubricating film only as they impinge on the bearing surfaces.

Journal of Commerce, New York, Vol. 226, No. 17, 243, Wednesday, October 4, 1950

LUBRICANT AVAILABLE IN SEVERAL NEW FORMS

Anon.—p. 4

Lubricants Division of Lockrey Co., College Point, N. Y., introduced a new type of oil, opening up several new possibilities in machine design, offering safe lubrication at higher speeds, pressures and temperatures. Technical Bulletin 21-E, put out by the company, describes Liqui-Moly NV Regular and Grease, Liqui-Moly NV Thread Compound and Moly-Wax-Stix. Liqui-Moly is a specially-treated compound of the greasy metal molybdenum, which is claimed to have the property of attaching itself by molecular attraction to metal bearing surfaces and which can take temperature extremes without harming its lubricating qualities. Liqui-Moly NV Thread Compound makes use of the ability of molybdenum to prevent metals from seizing or freezing together under extreme pressure. Moly-Wax-Stix offers a means of applying this lubricant in solid form.

Journal of the Institute of Petroleum, Vol. 36, No. 320, August, 1950

NEW METHODS FOR THE IMPROVEMENT OF LUBRICATING OILS

Michalowska, J.—p. 363A
(Nafta, Vol. 5, 1949, Jan.-Feb. 1949, pp. 24-8)

The author reviews the ideal beneficial results of additives and considers how far the actual compounds in use satisfy the demands made upon them. Their other properties are also reviewed. Paraflow, Santopour, and Elektrion R are mentioned for lowering the pour point, Exanol, Paratone, and Uniflow for raising the viscosity index as well as the Oppanol produced by Germany by polymerization of isobutylene. Amongst antioxidants the process for the Inhibitor R made by Germany is given. Against extreme pressure the Germans used Mesulfol 2, and the Dutch Medi-β-naphthol and other epols. As anticorrosives soaps, detergents, and the German K.S.E. ($R—CH_2°SO_2°NH°-CH_2°COOR$) are mentioned. Fillers and oiliness carriers are also mentioned in the article.

RATE OF LUBRICATING OIL CONSUMPTION IN INTERNAL COMBUSTION ENGINES

Tookey, W. A.—p. 362A
(Gas Oil Power, Vol. 45, 1950, p. 84)

In installations using oil power for the generation of electricity and the pumping of water, the Diesel Engine Users Association uses for comparing working costs: (a) the ratio fuel oil/lubricating oil; (b) the rated barrels horsepower hour per gallon of lubricating oil. As regards (a), ninety-seven engines gave an average of 55 with maximum and minimum of 127 and 24; as regards (b), sixty-two stations gave a mean of 2160, but the maximum and minimum were 11,000 and 800. Neither of these calculations, therefore, gives a reasonable basis for comparisons. All running engines need lubricating oil whether developing power or not, and the amount required will depend upon the number and size of the pistons, and their revolutions/minute. It is pointed out that for all normal engines the product of cylinder diameter and revolutions is approximately constant.

The Institute of Petroleum, Vol. 36, No. 321, September, 1950

LUBRICANT RESEARCH IN THE LABORATORY

Lamme, N.—p. 412A

No. 322, October, 1950

VISCOSITY-TEMPERATURE-PRESSURE RELATIONSHIPS OF LUBRICATING OILS

Sanderson, R. I.—p. 489A
(Lubr. Engng., Vol. 5, Dec. 1949, pp. 283-7

LUBRICATION SERVICING SYSTEM

Albl, O. M.—p. 489A
(Lubr. Engng., Vol. 6, No. 2, Apr. 1950, pp. 67-9)

Details are presented of the lubrication organization set up in a metal-working plant. Points covered include selection and testing of lubricants, scheduling of lubrication routine, and identification of types of lubricants with points of application.

IT'S THE CHEMIST WHO CHANGES YOUR OIL

Anon.—p. 491A
(Laboratory, Vol. 19, No. 5, 1950, p. 99)

A general review is given of the subject of additives in lubricating oils. In the last twenty years, the additive industry has increased to an annual production valued at $40,000,000/year. The various types of lubricating-oil additives are described, and an account of their modes of action is given. Some economic aspects of additive development are briefly considered.

Institute of Petroleum Review, Vol. 4, No. 45, September, 1950

STEAM TURBINE LUBRICATION

Broom, W. E. J. and Clark, G. H.—pp. 297-303

In Britain, industrial and domestic demands for electricity have, mainly due to the impetus of the war, outstripped generating capacity and it says much for the design and reliability of British power station equipment that so few major breakdowns of electrical supply have occurred considering that the majority of stations are seriously overloaded. The output of modern turbines has greatly increased over the past few years. At the same time as the size of the units increased, so did steam pressures and temperatures, so that turbines taking steam at 1600 pounds/square inch and 900°F are not uncommon. The development of new turbine oils and lubrication is now almost a minor function of the oil; 90 per cent of the oil passing through a bearing is used as a coolant, with 10 per cent acting as the lubricant. In addition, the oil is used as a hydraulic medium to operate governor gear and nozzle valves, and in hydrogen-cooled units as a sealing medium to prevent leakage of hydrogen.

Institute Spokesman, Vol. 14, No. 7, October, 1950

LUBRICATION LIFE FORECAST AND TEST PROCEDURE

Martin, H. D.—pp. 10-20

This article discusses the estimation of the life of sealed and shielded ball bearings in connection with various greases. The operation of the New Departure Testing Machine is described.

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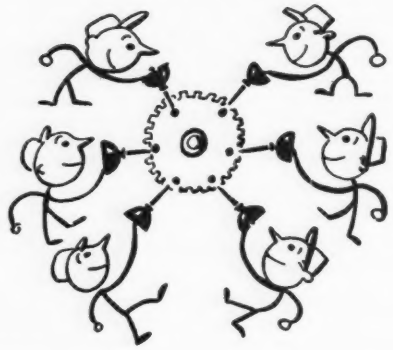

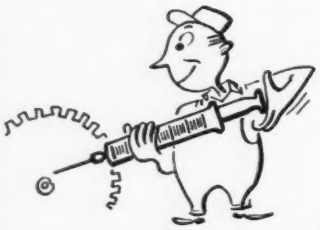

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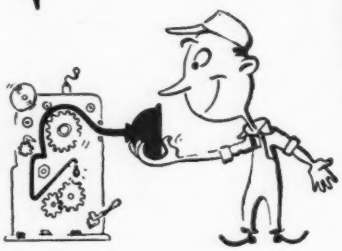

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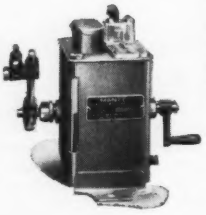

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No. 8, November, 1950

RELATIONSHIP BETWEEN PUMPABILITY & VISCOSITY OF LUBRICATING GREASES

Amner, J. W. Blott, J. F. T. and Dawtrey, S.—pp. 7-9, 11, 13, 15, 17

The subject is introduced by a brief discussion of the essential requirements to enable the flow of non-Newtonian systems to be predicted. Methods of measuring and expressing viscosity characteristics are considered and data are presented to illustrate the characteristics of different types of greases. Experimental evidence is given which demonstrates the validity of applying viscosity data to the prediction of the flow of grease on its pumpability under a variety of practical conditions is discussed.

INHIBITED NORMALLY UNSTABLE GREASES

Anon.—p. 22

Hydrogenated fatty materials employed for grease purposes are very susceptible to oxidative deterioration, presumably because of destruction of natural inhibitors during hydrogenation operation. This is particularly so in the case of hydrogenated fish oils and fish oil acids which, in other respects, are excellent grease constituents. A patent issued to Standard Oil Development Co. (U. S. 2,522,460) discloses that such hydrogenated fatty materials deteriorate rapidly with use due to the formation of peroxides, lactones and other oxygen bearing materials which catalyze further oxidation, resulting in rancidity, foul smelling, and separation or bleeding in storage. These acids and other oxidation products react chemically with the bearing materials and also tend to clog parts and prevent proper lubrication. It has been found that greases containing such hydrogenated materials can be inhibited by use of certain non-toxic carbon blacks which act as oxidation inhibitors and prevent deterioration over relatively long periods of time.

SODIUM-BARIUM GREASES FOR ANTI-FRICTION BEARINGS

Anon.—pp. 22, 25

Lubricating high speed anti-friction bearings over a broad temperature range has been disclosed in U.S. patent 2,514,330 issued to Standard Oil Development Co. This patent points out that a previously disclosed grease covered in U.S. 2,245,702 made with soda and baryta had given fairly satisfactory lubrication but had certain deficiencies in that it was not useful over a wide temperature range as desired. It was found that unexpected improvements may be obtained by employing fatty acids of lower average molecular weight than acids used in the prior art and by employing a base lubricating oil of high viscosity index.

POLYALKYLENE GLYCOL GREASES

Anon.—p. 25

Millet of Carbide & Carbon disclosed several new greases produced from polyalkylene glycols. One has been successfully used at temperatures as high as 250°F and as low as —70°F, while another is specifically designed for high temperature service.

(*Continued on page* 45)

OILS AND LUBRICANTS

PATENT ABSTRACTS

Printed copies of patents are available from the Patent Office at twenty-five cents each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

From Official Gazette—Vol. 640, Nos. 1, 2, 3, 4; Vol. 641, Nos. 1, 2, 3, 4.

Prepared by ANN BURCHICK

Reaction Products of Diesters of Dithiophosphoric Acid and Mineral Oil Compositions Containing the Same — Patent #2,528,732 — Frederick B. Augustine, assignor to Socony-Vacuum Oil Co., Inc.

A mineral lubricating oil containing a minor proportion, sufficient to improve the stability thereof against deterioration by oxidation, of a reaction product obtained from the reaction involving about one mol of a diester of dithiophosphoric acid in which all alkyl radicals in the diester are saturated, with one mol of an organic compound containing at least one double bond in a straight chain of carbon atoms at least four carbon atoms in length, said organic compound being selected from the group consisting of aliphatic hydrocarbons, alcohols, fatty acids and their esters, and containing not less than eight carbon atoms, at a temperature falling within the range varying between about 100 C. and about 200 C.

Mineral Oil Composition—Patent #2,528,773—Henry D. Norris, assignor to Socony-Vacuum Oil Co., Inc.

A mineral lubricating oil containing a minor proportion sufficient to improve the stability thereof, of a product obtained from the reaction involving from about one to two mols of a thenylchloride type of compound with about one mol of a sulphur-containing compound of the group consisting of alkali and alkaline earth metal salts of polythiocarbonic acid esters, alkali and alkaline earth metal sulphides and alkali and alkaline earth metal mercaptides.

Mineral Oil Compositions Containing Alkyl Aminobenzothiophenes — Patent #2,528,785 —Frederick P. Richter and Everett W. Fuller, assignors to Socony-Vacuum Oil Co., Inc.

A mineral lubricating oil containing a minor proportion, sufficient to improve the stability of said oil against oxidation, of a material selected from the group consisting of alkyl 2-monoaminodibenzothiophenes, alkyl 8-monoaminodibenzothiophenes, and alkyl 2,8-disminodibenzothiophenes, in which the alkyl radicals contain not less than four but not more than twenty-four carbon atoms and are connected to carbon atoms of the dibenzothiophene nucleus.

Lubricating Metal Surfaces During Cold Working — Patent #2,529,190 — Albert G. Rocchini and Richard J. Neely, assignors to Gulf Research & Development Co.

In cold working a metal subsequently to be annealed, the improvement which comprises lubricating the surfaces of the metal being worked by establishing and maintaining thereon a film of lubricant comprising a petroleum lubricating oil which would normally tend to stain said metal surfaces during annealing thereof and between about 0.01 and 1.0 per cent by weight of a chlorophenyl phosphate selected from the group consisting of diphenyl mono(orthochlorophenyl)-phosphate and diphenyl mono(para-chlorophenyl) phosphate.

Lubricating Oil Compositions—Patent #2,529,300—Eugene Lieber, assignor to Standard Oil Development Co.

A composition comprising a major proportion of a waxy mineral oil and, associated therewith, a minor proportion of a wax-modifier consisting essentially of a Friedel-Crafts condensation product about 1 to 5 mols of a compound containing not more than 20 aliphatic carbon atoms and having the general formula R_nAr--OH, in which R is an aliphatic group having less than 12 carbon atoms, n equals 1 to 2 and Ar is an aromatic nucleus, with about 1 mol of an aromatic dibasic acid acylating agent having the general formula $Ar'-(COX)_2$, in which Ar' represents an aromatic nucleus and X is selected from the class consisting of OH and a halogen, said condensation product being substantially non-volatile at temperatures up to about 600 F.

Extreme Pressure Lubricants—Patent #2,529,304—Louis A. Mikeska and Elmer B. Cyphers, assignors to Standard Oil Development Co.

An extreme pressure additive composition for mineral oil base lubricants consisting essentially of the condensation product of a halogenated fatty material containing at least two halogen atoms with an alkali metal salt of a dithiophosphoric acid diester, each of the esterifying groups of said ester being selected from the class which consists of alkyl and alkaryl radicals of 2 to 10 carbon atoms in the alkyl chain.

Process for Acylating Butadiene-Styrene Copolymers—Patent #2,523,316—William H. Smyers and Edward P. Cashman, assignors to Standard Oil Development Co.

A process of preparing a suitable pour point depressing composition for use in lowering the pour point of waxy mineral base lubricating oils which comprises reacting about one part by weight of a solid rubbery copolymer of from 60% to 80% by weight of butadiene and from 20% to 40% by weight of styrene, which copolymer has an iodine number of at least 200, with from one to 5 parts by weight of stearyl chloride in the presence of a solvent inert to the copolymer and from 0.5 to 3 parts by weight of a Friedel-Crafts catalyst at a temperature within the range of from 125 to 250 F. for a period of time of from ½ to 10 hours and until the iodine number of the resulting composition is less than 100.

Process of Preparing Synthetic Drying Oils—Patent #2,529,322—John C. Zimmer and Jeffrey H. Bartlett, assignors to Standard Oil Development Co.

A process of preparing synthetic drying oils which comprises condensing at a temperature above 100 C. a polyolefinic polymer having a molecular weight between 200 and 1000, obtained by the clay treatment of steam cracked gasolines with a compound selected from the group consisting of alpha, beta unsaturated carboxylic acids and alpha, beta unsaturated nitriles and then esterifying the product with an alcohol having from 2 to 20 carbon atoms in a straight chain at a temperature between 100 and 200 C.

Mineral Lubricating Oil Composition — Patent #2,529,523—Franklin M. Watkins, assignor to Sinclair Refining Co.

A lubricating composition comprising a mineral oil base and blended therewith, in a proportion adequate to impart a detergent property to the composition, a mineral oil concentrate of compounds conforming to the formula.

$$(RCOCH_2—SO_3)_nM$$

where R represents alkaryl radicals derived from a mineral oil containing aromatic hydrocarbons having alkyl side chains of from about 10 to about 26 carbon atoms, n is 1 or 2 and M is from the group consisting of the alkali and alkaline earth metals.

Preparation of a Hydrocarbon Drying Oil—Patent #2,529,590—Herman S. Bloch, assignor to Universal Oil Products Co.

A process for the production of a hydrocarbon material having drying properties which comprises contacting at a temperature below about 200 C. an aluminum halide of a middle halogen with an olefinic hydrocarbon and a molar excess of a hydrogen halide of a middle halogen, said molar excess being based upon the quantity of aluminum halide utilized, continuing the reaction until a molar equivalent of the hydrogen halide relative to the amount of aluminum halide has combined with the latter and with said hydrocarbon, separating from an upper, substantially saturated, hydrocarbon layer a lower layer comprising an aluminum halide-hydrogen halide-hydrocarbon complex addition product, subjecting said lower layer to hydrolysis to liberate the hydrocarbons from the complex addition product, and recovering the thus liberated hydrocarbons.

Compounded Petroleum Hydrocarbon Products—Patent #2,530,339—Louis A. Mikeska and Allen R. Kittleson, assignors to Standard Oil Development Co.

A product consisting essentially of a petroleum hydrocarbon material and from about 0.02 to about 2% of an aromatic methylene product of a thio acid of phosphorus, such product being a member of the group.

Lubricating Compound—Patent #2,530,804—Sidney Bloomenthal and Fredric E. Wood, assignors to Automatic Electric Laboratories, Inc.

A lubricating compound comprising approximatelv 30% of a mixture of a petroleum lubricating oil with a wax having a wax melting point above about 150 F. and having incorporated therein an amount of aluminum soap such that the ratio of soap to wax is of the order of 1:15; 15% of a mixture of non-gaseous hydrocarbons containing small amounts of a poly carboxylic acid having at least 16 carbon atoms, and of a mutual solvent for hydrocarbons and water; and 55% of dibutyl.

Lubricant Composition Composed of High-Titre Soap, Borax, and an Inorganic Compound — Patent #2,530,837 — Gilbert H. Orozco and John A. Hendricks, assignors to Gilron Products Co.

A water soluble lubricating composition for use in the formation of metal articles consisting essentially of at least about 15% of an organic lubricating material selected from the group consisting of a water soluble high titre soap and a mixture of water soluble high titre soap and organic water soluble aliphatic, polyhydric alcohol having less than four hydroxy groups, and at least two lubricating, water liberating, hydrated, glass forming, water soluble inorganic materials selected from the group consisting of metal phosphates, metal carbonates, metal silicates, metal borates and boric acid, one of said inorganic materials being borax and present in an amount at least about 40% of the total composition and greater than the amount of any other inorganic material present in the composition, the amount of the total inorganic material being greater than the amount of the organic lubricating material, the melting point of the organic lubricating material being less than that of any of the inorganic materials, and the inorganic materials each having a melting point below 1000 C and each having a melting point different from each other, each inorganic material being present in an amount sufficient to provide and maintain lubrication throughout a material range of temperature different from each other, and the organic material being present in an amount sufficient to provide and maintain initial lubrication up to a temperature at which the inorganic material of lowest melting point becomes operative, whereby the composition will provide progressive and stepwise lubrication of the metal during the forming operation.

Wire, Rod, and Sheet Metal Drawing Lubricant of Synthetic Wax, Borate, and Organic Binder—Patent #2,530,838—Gilbert H. Orozco and Richard F. Roy, assignors to Gilron Products Co.

A coating material for admixture with water for coating a piece of unformed metal stock and the like and forming thereon a self-adherent, homogeneous, lubricating and protecting film comprising the following ingredients by weight, dry:

(*Continued on page* 47)

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NEW YORK—D. B. Gordon, Socony-Vacuum Oil Co., Inc., 230 Park Ave., New York 17, N. Y.

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Honan-Crane purifier using Cranite (specially processed Fuller's earth) continuously serves the 1200 HP. Model 33FD Fairbanks, Morse dual fuel unit at Lindsborg, Kansas Municipal Power Station

CURRENT LITERATURE

(*Continued from page* 42)

ALUMINUM SOAP GREASES

Anon.—pp. 25, 28

Standard Oil Development Co. patent (U.S. 2,521,395) discloses an improved aluminum soap base lubricating grease suitable for use on chassis, etc. and is modified to improve its texture. Addition of a substantially saturated acid in the quantity of 10-20% of the aluminum soap, together with use of an alkylated phenol modifier in reduced quantities, has been found to give a grease with reduced acids and soaps is discussed by Davey.

***Lubrication Engineering*, Vol. 6, No. 5, October, 1950**

ORGANIZED LUBRICATION IN A MANUFACTURING PLANT

Danse, L. A.—pp. 206-207, 238

This article takes up lubrication in a manufacturing plant. Choice of lubricants is considered.

GENERAL GREASE CHARACTERISTICS VS. BEARING REQUIREMENTS

Roehner, T. G.—pp. 220-224

This paper was presented at the Philadelphia Section of the American Society of Lubrication Engineers. One approach to the problem is to define the requirements of the bearings in terms of grease characteristics. The author takes up method of application, bearing operating conditions, frequency of application and bearing design. The use of the wide range of properties of currently available greases depends on the meshing requirements of the bearings with knowledge of the performance characteristics of the greases.

OIL RECLAIMING SYMPOSIUM, DETROIT, APRIL 11, 1950 (FIFTH ANNUAL CONVENTION, AMERICAN SOCIETY OF LUBRICATION ENGINEERS)

RECLAMATION OF INDUSTRIAL PETROLEUM PRODUCTS

Cleaveland, D. M.—pp. 208-209

RECLAIMING OF USED LUBRICATING OIL

Black, A. R.—pp. 209-210

RECLAIMING INDUSTRIAL PETROLEUM PRODUCTS

Goodale, R. W.—pp. 210-212

CENTRIFUGAL RECLAMATION OF INDUSTRIAL PETROLEUM PRODUCTS

Reed, K. D.—pp. 212-213

RECLAIMING PETROLEUM PRODUCTS BY FILTRATION

James, W. S.—pp. 213-214

AVIATION LUBRICATING OIL RE-REFINING PRACTICE

Hendren, J. T.—pp. 214-215

RECLAMATION OF CRANKCASE LUBRICATING OIL FOR RAILROAD DIESEL LOCOMOTIVES

Lasky, W.—pp. 215-217

OIL FILTRATION IS LUBRICATION INSURANCE

May, E. M.—pp. 218-219

RE-REFINING OF USED MINERAL OILS BY TREATMENT WITH ACTIVATED CLAY AND HEAT

Ebrey, G. O.—p. 219

This series of articles discusses reclaiming used lubricating oils by various methods including filtering, centrifugal separation, re-refining, treatment with clay and heat.

***Metal Progress*, Vol. 58, No. 3, September, 1950**

FORGING DIE LUBRICATION

Lang, W. E.—pp. 337-339

The author recommends a thin water emulsion of colloidal graphite for hot-work dies.

***National Petroleum News*, Vol. 42, No. 46, November 15, 1950**

DICTATION OF OIL SPECIFICATIONS CAN HURT INDUSTRY, PUBLIC, BOEHM SAYS

Boehm, A. B.—p. 56

Oil product development versus specifications continues to be a controversial issue. Because of the interest in this topic, National Petroleum News present herewith a condensation of a paper given Nov. 13, 1950 before the California Section of American Chemical Society (Petroleum Group) at Berkeley, California, by A. Bruce Boehm, sales manager, Enjay Co., Inc. "Can the petroleum industry continue to tie its commercial lubricating oil development work to military or engine builders' specifications without injury to its research, to the significance of its brands and to the ultimate objective of giving the consumer the best for his needs that his dollar will buy?"

Oil and Gas Journal, Vol. 49, No. 23, October 12, 1950

NEW NAMES RECOMMENDED
Anon.—p. 140

Heavy-duty lubricating oil now covers so many grades that a new system of nomenclature is recommended by the American Petroleum Institute. A panel has been named to study the procedure, headed by Ludlow Clayton, Sun Oil Co.

Oil, Paint and Drug Reporter, Vol. 158, No. 21, November 20, 1950

WITCO HAS NEW PLASTICS STABILIZER AND LUBRICANT
Anon.—p. 83

Witco Chemical Company, New York, has developed a new high lead content primary heat stabilizer and internal lubricant for polyvinyl chloride resins and copolymers. Called "Witco Lead Stearate No. 50," the new stabilizer is said to fulfill the heat protective requirements of most vinyl compounds in which lead salts are suitable. The company has issued a new technical service report (S-4), entitled "Witco Lead Stearates—Stabilizers and Lubricants for Polyvinyl Chloride Plastics." The publication gives pertinent technical data on both the new product and "Witco Lead Stearate No. 30," a general purpose lubricant and stabilizer.

Petroleum, Vol. 13, No. 10, October, 1950

LAUNCHING LUBRICANTS
Anon.—p. 268

Two new launching lubricants, BASE-KOTE and SLIDEKOTE, are mentioned. They are wax-like (high film strength) and greasy respectively.

No. 11, November, 1950

THE DEVELOPMENT OF EXTREME PRESSURE LUBRICANTS
Davey, W.—pp. 279-282

The development of suitable lubricants for use under extreme conditions is described, the mechanism of action of such lubricants discussed and recent advances in the production of Extreme Pressure Additives is outlined. Fatty oil and sulfur lubrication, lead soap-sulfur lubricants, chlorine-sulfur lubricants, phosphorus-containing lubricants are discussed.

Petroleum Processing, Vol. 5, No. 10, October, 1950

NON-SOAP LUBRICATING GREASES
Matthews, R. R.—pp. 1082-1084

The recent development of products using solids as thickeners provides additional cause for changing trade's accepted definition of lubricating greases.

10 WAYS TO STOP LOSSES IN LUBRICATING PLANT EQUIPMENT
Jahnke, L. F.—pp. 1068-1069

Startling losses frequently occur thru inadequate and improper lubrication of the machinery and equipment in a refinery. A checklist of 10 significant factors is presented as a means for determining the efficiency of lubrication methods. A pattern is also given for installing a practical lubrication system, based on the needs of the individual plant. The paper was presented at the Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, in New Orleans, Sept. 24-28.

SPECIAL STAFF PRESCRIBES, FOLLOWS UP LUBRICATION OF REFINERY EQUIPMENT
Leverett, F. M.—pp. 1070-1071

A plant lubrication program is described as organized in a large refinery processing around 200,000 barrels per day of crude. Headed by a trained lubrication engineer, his department handles and distributes all supplies used in lubricating the plant equipment, in addition to prescribing the lubricant and supervising its application. The paper was presented at the Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, in New Orleans, Sept. 24-26.

The Petroleum Times, Vol. 54, No. 1388, October 20, 1950

BRITISH LUBRICATING OIL RESEARCH
Anon.—pp. 709-710

This article discusses briefly the performance testing of engine lubricants by means of the Perry engine at the British Lubricating Oil and Grease Research Organization, Ltd., at Yeading, England.

Power, Vol. 94, No. 11, November, 1950

ADDITIVES ADAPT LUBE FOR MORE JOBS
Anon.—pp. 87-89

The commercial application of chemical additives on a large scale began about 1930. Tomorrow additives will be used more in combination with synthetic oils. Lubricity agents, oxidation inhibitors, rust inhibitors, viscosity index improvers, detergent additives and defoaming agents are taken up.

Revue de L'Institut Francais du Petrole et Annales des Combustibles Liquides, Vol. 5, No. 11, November, 1950

SYMPOSIUM ON THE PHYSICS OF LUBRICATION HELD AT THE UNIVERSITY OF MANCHESTER, JUNE 29, 30 AND JULY 1, 1950
Anon.—pp. 367-368

Scientific Lubrication, Vol. 2, No. 9, September, 1950

AIRCRAFT LUBRICATION
Hunt, K. C.—pp. 15-20

The three most important aircraft power plants are:—1. The piston engine driving a propeller. 2. The jet reaction engine, commonly called the Turbo Jet. 3. The gas turbine, driving a propeller, commonly called the Prop-Jet. In this first article the author deals with the aircraft piston engine. The high specification requirements of aviation oils would seem to make it quite impracticable even to consider used oil reclamation. However all important U.S. airline operators and most Air Forces now "reclaim" tank drainings, usually by steam stripping and earth treatment and then use the recovered oil quite indiscriminately in any proportion with fresh oils.

FIRST PRINCIPLES; A SERIES OF ARTICLES EXPLAINING IN SIMPLE LANGUAGE THE FUNDAMENTALS OF LUBRICATION; No. 14. DILUTION
Anon.—pp. 28-29

Lubricating oil used in all internal combustion engines is liable to become contaminated with fuel. The ways in which fuel can gain access to the crankcase are discussed.

No. 10, October, 1950

THE VISCOSITY-TEMPERATURE DEPENDENCE OF LUBRICATING OILS
Branker, A. V.—pp. 22-23

This paper discusses the limitations of the fundamental viscosity-temperature equation with particular reference to the effect of additives on viscosities of oils. A modified equation is proposed which gives a linear relationship between η/T and $1/T$ over a range of temperature extending from 60°C to —38°C for Avtol oil, and 100°C to —10°C for water.

METAL TRANSFER FROM PISTON RINGS TO CYLINDERS DURING RUN-IN
Strang, C. D. and Burwell, J. T.—pp. 24-27

This paper is a shortened version of the original which was presented to the Institution of Mechanical Engineers for written discussion. The work was carried out by the Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Piston rings with radio-active wearing surfaces have been used to study the micro-welding between rings and cylinder wall during "run-in" in a small water cooled i.c. engine. The results indicate that the micro-welding and the accompanying transfer of metal are present under the mildest conditions of engine operation. Examination of local welding, or adhesion, shows to what extent the lubricating film is completely ruptured, locally, under boundary lubricating conditions because such welding would not take place if even a monolayer of lubricant interposed the surfaces. Hence, this work points to a further method of securing information regarding the effectiveness of lubricants under "run-in" conditions and in connection with the reduction of galling and scuffing.

Soap and Sanitary Chemicals, Vol. 16, No. 10, October, 1950

SILICONE SOAP LUBRICANTS
Anon.—p. 71
(Glycerine Facts, September, 1950)

Silicone greases have been found to perform satisfactorily with equipment employing sealed bearings and operating under wide temperature ranges. However, these greases lack resistance to shear. This problem is overcome by use of the special acid components of metal soaps. A typical formula for a product of this type is as follows: 12.8 per cent lithium soap; .9 per cent glycerine; 13.5 per cent mineral oil; and 72.9 per cent dimethyl silicone polymer. The metallic component of the soap may be sodium, calcium, barium, or aluminum.

Steel, Vol. 127, No. 15, October 9, 1950

GRAPHITE LUBRICATING PAYS OFF

Anon.—p. 98

Graphite due to its ability to fill in low spots on journal and bearing, enables operators to keep equipment in operation which otherwise would have to be shut down for over-haul. Graphite lubricates bearings operating at temperatures which will carbonize oil and greases. Graphite supplied in paste form is diluted with a thinner and applied to the surface; after drying the film provides dry lubrication and does not collect and hold dust and dirt. The paste is being used on center castings, diaphragms, buffer assemblies, etc., and on diesel locomotives where sliding friction occurs. Railroads use it for lubricating switch plates at reported reductions of 50 per cent in lubricating costs. Graphite mixes readily with oils and greases and does not chemically react with other materials. It withstands pressures and temperatures beyond the range of oils and greases. In most cases it reduces power consumption and maintenance costs.

World Petroleum, Vol. 21, No. 12, November, 1950

HIGH-ADDITIVE-CONTENT LUBE OILS

Anon.—p. 88

A new type of lubricating oil was discussed at the October 1949 meeting of the American Society for Testing Materials Committee D-2 on petroleum products and lubricants at San Francisco. These new oils, known as Series 2, differ from previous heavy duty oils as they contain from five to ten times as much additive and may have as much as 2% ash constituents. They were developed at the request of the Caterpillar Tractor Co. to meet a field condition involving severe operation of diesel engines, using fuels with as much as 1% sulfur. These new lubricants eliminate almost all corrosive wear and engine fouling in the diesels using these high sulfur fuels. Five papers contributed to the symposium published by the American Society for Testing Materials at Philadelphia, "Symposium on High Additive Content Oils", $1.75.

Patent Abstracts

(*Continued from page* 43)

Component A:

	Parts
A synthetic wax having a melting point of at least about 95 C.	10-40

Component B:

A boron containing material selected from the class consisting of metal borates, borate ores, mixtures of the foregoing, and any of the foregoing admixed with a minor amount of a material selected from the group consisting of colloidal clay, water-soluble silicates, and water soluble carbonates.	85-35

Component C:

A water soluble organic lubricating binder which is inert with respect to other material in the composition and has a melting point of at least about 10 C. and an initial distillation point of at least about 200 C.	5-25

Lubricants—Patent #2,531,440—John W. Jordan, assignor to National Lead Co.

A bodied lubricant, comprising essentially, an organic lubricating liquid having colloidally dispersed therein a clay originally exhibiting a base-exchange capacity of at least 25, in which the exchangeable inorganic action has been exchanged for an onium base of a type capable of and to an extent sufficient to form an onium-clay swelling to at least eight-fold in nitrobenzene.

Upsetting-Die Lubricant for Application to Bolt Stock or the Like—Patent #2,531,553——Charles G. Canney, assignor to The American Steel and Wire Co. of New Jersey.

A wire drawing lubricant comprising from 70 to 90% hydrated lime and from 10 to 30% of a grease composed of substantially 85% mineral oil and 15% soap, said oil having originally a gravity of approximately 24°Be', a flash point of approximately 340 F., a fire point of approximately 395 F., and a Saybolt viscosity of 150 seconds at 100 F., the said grease having a penetration value of from approximately 265 to approximately 290, a melting point of approximately 195 F., and a moisture content of from approximately 1 to 1.5%.

Lubricating Oil Composition—Patent #2,531,801 — Edward S. Blake, assignor to Monsanto Chemical Co.

A compounded lubricating oil comprising predominately a mineral lubricating oil, said oil having incorporated therein 0.1% to 10% with respect to the oil base of an oil soluble partial ester of a higher fatty acid containing at least 6 but not more than 22 carbon atoms and a polyhydric alcohol further esterified with a saturated aliphatic hydroxy polycarboxylic acid having not more than three carboxyl groups and at least one hydroxyl group not more than two carbon atoms removed from a carboxyl group of said acid.

Prevention of Rust—Patent #2,533,304—Franklin M. Watkins, assignor to Sinclair Refining Co.

A petroleum oil distillate to which a rust-inhibiting property has been imparted by the incorporation of 1 to 100 parts per million of triamylamine mahogany sulfonate.

Mineral Oil Composition Containing Thienyl Sulfides—Patent #2,534,223—John W. Brooks and Alexander N. Sachanen, assignors to Socony-Vacuum Oil Co., Inc.

An improved mineral oil composition comprising a major proportion of mineral oil and in admixture therewith a minor proportion, less than about 10% by weight but sufficient to stabilize the oil against the deleterious effects of oxidation.

Watch Oil—Patent #2,534,611—Joseph S. Martin, Jr., assignor to Hamilton Watch Co.

A lubricant consisting of the ester of phenyl "Cellosolve" (mono-phenyl ether of ethyelne glycol) and 9- and 10-phenyl stearic acid.

Lubricating Compositions — Patent #2,535,024 — Charles Earle Funk, Jr., assignor to American Cyanamid Co.

Process for preparing a solution in mineral oil of a heavy metal salt of an oil-soluble ester of dithiophosphoric acid which comprises the steps of adding an oil-soluble ester of dithiophosphoric acid to a dispersion in mineral oil of a member of the group consisting of the oxide and hydroxide of barium, said dispersion containing from about 0.5% to about 5.0% of methanol, reacting the said materials at a temperature of from about 20 C. to about 90 C. while retaining in the solution an amount of methanol sufficient to carry out complete neutralization of the acid dithiophosphoric ester, and removing the oil-soluble reaction salts by filtration.

Sulfonate Base Lubricating Grease—Patent #2,535,101 — Lorne W. Sproule and Warren C. Pattenden, assignors to Standard Oil Development Co.

A grease composition consisting essentially of mineral lubricating oil containing 5 to 25% by weight, based on the total composition, of an oil soluble sulfonate having a sulfonate radical molecular weight of more than 300 and not substantially greater than about 500, and 3 to 20% of a non-oil soluble sulfonate of a sulfonic acid having a molecular weight between 96 and 250, the combined sulfonates being effective to impart a grease-like consistency to said oil.

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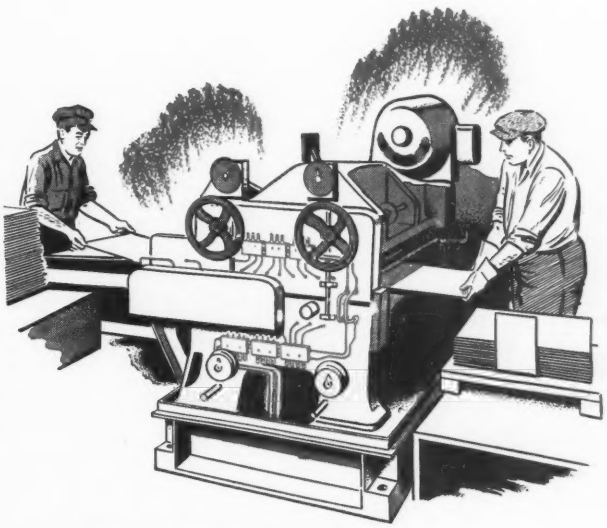

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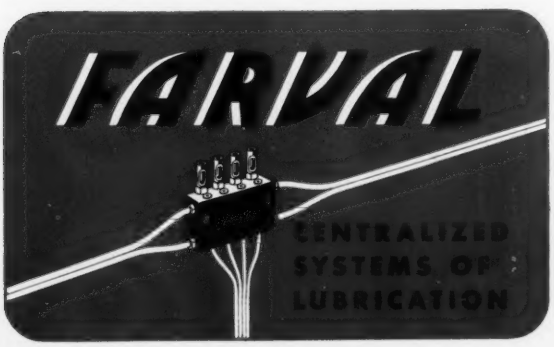

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